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The Polishing

AND

Plating of Metals

A Manual for the Electroplater, giving Modern Methods of Polishing, Plating, Buffing, Oxydizing and Lacquering Metals, for the Progressive Workman.

BY HERBERT J. HAWKINS

With Numerous Illustrations and Formulæ.

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CHAPTER I.

VARIOUS KINDS OF ELECTROPLATERS.

There are all sorts and conditions of men among electroplaters. Some few among them are unusually well-informed and intelligent men, masters of their art and of many things not immediately connected with it; but the majority of the rank and file, as in most other businesses, either from force of circumstances or from choice, have confined themselves to one line or class of plating, until they have become specialists. This course is, we think, rarely adopted deliberately, but goes on gradually and unconsciously, from the fact that they have had the most experience, and consequently the best success in particular lines; and so we have nickel platers who know little of gold or silver work, jewelry platers who cannot successfully use nickel and copper on large work, platers of iron and steel who are lost on silver ware and musical instruments, etc.

When such a man is driven from his particular line by the temporary loss of a situation, he is apt to feel keenly his deficiencies in the general knowledge of his profession and to make spasmodic attempts to remedy them. Under these conditions, reference to his ability in nickel plating in a jewelry town, or compliments on his skill with gold in a copper plating plant, are apt to strike him as a bitter mockery and make him regret the fact that he allowed himself to become a specialist—even a skilled one.

This is a wrong condition of things, to say the least. Any person following the plating business as a means of earning a livelihood should have the whole category of solutions, classes of work and the different methods of handling them well within his grasp, so that if one line of work is overcrowded and underpaid, he may seek employment in another line; or if one position is unsatisfactory, he may seek another with a reasonable hope of finding something to his liking. The old adage that a rolling stone gathers no moss may be true, but a plater does not need moss, and the rolling stone surely gathers polish, which, in the case of the plater, is equivalent to experience and knowledge. No plater can hope to become an all-round workman, capable of handling successfully any position which may be offered him, except by actually doing commercially the various classes of work he is desirous of being capable in. The only way to practically and completely obtain this knowledge heretofore has been to change about from shop to shop, getting positions on different classes of work. The best places to gain this knowledge are the large job shops in Providence, New York, Philadelphia, Chicago and other large cities. Some of these shops handle everything that comes their way in plating, polishing or coloring, from a pants button to a Pullman palace car, or eight and ten foot panels for the main entrance of a "sky-scraper." The work in such shops is handled quickly, cheaply and usually in large quantities, so that the wideawake plater, seeking knowledge, may have his wish gratified by obtaining a few months' employment in one after the other of such establishments. He should get on friendly terms with the head plater, not only for what he can learn, but also in order to make the acquaintance of other platers. He should always have a notebook and pencil handy, but learn to use them without attracting too much attention, make the best use of his opportunities and absorb as much knowledge as is possible in the various shops in which he chances to be employed. As a general rule, platers are very liberal with their knowledge and are willing to set right their brother workmen with limited experience. There are some exceptions to this rule, however; some platers who have actually become so hidebound as to refuse to give out any knowledge, if they possess it. An investigation will usually show, however, that platers of this class generally have a very limited knowledge themselves and are afraid that they may lose what little advantages they do possess.

If a practical man in the plating business knows a certain thing, it is folly for him to guard it as a secret because its value does not lie in the knowing, but in his ability to apply that knowledge; thus, I might tell a dozen platers the formula for a certain shade to finish in French gray, or rose gold, yet they would not be able to get just the same results that I would; in fact, they would all, very likely, get a little different shade of finish upon the work. It is not the formula that gets the results, but the individuality of the operator, and his experience and skill are what count.

A general knowledge of chemistry pertaining to plating should be very beneficial to the practical plater, although I have known practical chemists to make very ordinary platers. A thorough knowledge of dynamos and electricity should also be of value. Both of these are obtainable at small cost in this age of night schools and correspondence schools.

But what shall we say of the man who, from circumstances beyond his control, is unable to move about from city to city and from shop to shop, standing the sometimes heavy loss in idle time and expense, for the sake of buying experience? Is there a night school for him, as well as for the chemist and electrician? I am sorry to say that there is not. Chemistry and electricity he should certainly study at the night schools; they will unlock for him a world of mystery in his daily work and give him advantages, the extent of which he cannot appreciate until he has acquired them. But the science of electroplating is so new, and is changing so rapidly, that the writers on the subject are comparatively few and those we have are generally students, rather than practical men. In a business compounded so intimately of mechanical, chemical and electrical processes, the student is apt to minimize or overlook altogether the importance of matters outside those in which he is interested. Thus, we have chemists experimenting on solutions, electricians improving the means of handling electricity, mechanics designing improved machinery, salesmen pushing the sale of all of them, but no one to whom the plater can go for an estimate of the relative importance of these improvements in the plating shops.

There are books on plating, certainly but they are of two classes (1) treatises which require a knowledge of chemistry, and then have to be read with discrimination and allowance made for the difference between laboratory experiments and shop practice; and (2) compilations from the note books of practical platers through a long series of years. The latter class are the ones most frequently purchased by practical platers and afford considerable assistance to those who have sufficient knowledge of the business to reject at a glance the old formulæ and discarded recipes with which they are cumbered and to select intelligently and use with skill the finishes and solutions which are necessary occasionally in the jobbing shop.

Nothing ever comes out of these books. Edition after edition is sold and each subsequent edition contains all of the matter found in its predecessors and whatever may be added from its contemporary publications and the trade journals. Each new edition is proudly advertised as "revised and enlarged;" enlarged, certainly, but not revised, for nothing is ever thrown away. Many of them print page after page of formulæ, only to add at the bottom that so and so says they are useless. As historical collections they are valuable, but to the young plater they are misleading and unsatisfactory.

Technical books are generally ten years behind the most advanced practice in any line, for the reason that it takes about that time for the experimental practice to become standardized and accepted. This is particularly the case in the plating business, because, as a commercial pursuit it is less than fifty years old and has been constantly combining chemical, electrical and mechanical processes, all of which are advancing rapidly and unevenly, so that it has been obliged to keep pace with three separate and distinct sciences.

In such a case all that is left the plater to do is to buy the books as they are published, read them with discrimination and reject all that he finds will not work out in shop experience.

This may seem strange language from a man who is himself writing a book, but I have found it to be a sober statement of fact, and I am personally acquainted with so many platers who have bought everything that is published and then been disappointed, that I am sure most platers of experience will agree with the above statements. I know of but one book on plating that has been written from the standpoint of the electroplater and that is designed for the apprentice; but the demand for it has been so large that I am tempted to give the trade something from the same point of view only more complete, and I expect to get the same treatment from my readers that I have advocated in the preceding paragraphs.

Salesmen from the supply houses form a very important source of information for the plater. They are generally up-to-date and, if so inclined, can give the isolated plater much that he should know; and frequently they are a very substantial help to him. They are on intimate terms with platers all over the country, and their opportunities to observe the efforts of skilled men are unlimited. Cultivate the travelers, by all means; you will be well repaid for your trouble.

What the isolated plater, or the inexperienced man most needs, I think, is to take a general survey of the work, in its relative importance to that which has preceded and will follow; and in this manner he will find of supreme importance in his work many things that the student and the scientific man either ignore or take for granted. So I am tempted to emphasize these things, and if much that is set down here does not appear in other works on plating, the skilled men in the profession who may chance to see this must remember that I am not seeking to enlighten them, or air my own opinions, but to tell a few things that others have ignored and which the younger element of the trade have not yet learned.

CHAPTER II.

SOME POINTS ON HYGIENE FOR PLATERS.

It is of the utmost importance to the professional plater that he should understand something of the effects of the hydrocyanic acid fumes, and the fumes of other acids and chemicals used in the plating room. The writer can state positively, from a very dear experience, that it is important for any one who expects to follow electroplating for a livelihood to start in as he can hold out. Without wishing to discourage any one who may have a desire to follow this very interesting and instructive line of work, I deem it wise as an old-timer at the business to give some of my experiences with the different chemicals, and their escaping gases, which are in common use by platers. While stating their effects upon my general health I desire to say that the same conditions may effect other people differently, or not at all. I am acquainted with platers who have been at the business for twenty years or more without any outward sign of broken health. On the other hand, men at the trade for a few years only are often taken with sickness of some kind, caused by inhaling the noxious gases in the plating room, sometimes unavoidably and sometimes through carelessness.

Some platers are disabled for a time and forced to rest on account of their systems being more susceptible to the actions of the solutions and fumes. For instance, the hands of some men are much more easily poisoned by cyanide solutions than others. The cyanide, getting in cuts, or under the nails, and in the pores of the skin, causes a burning, feverish sensation, which is very painful. The hands swell up and sometimes the arms swell also. Sores arise frequently, where there has been any scratch or cut on the skin. These maturate and form a round hole; they are very painful until the fever subsides and they begin to heal; when the matter is removed, a hole or pit is left, which heals quickly, if kept clean and dry.

In case the hands or arms become swollen or poisoned, a rest from work should be taken until they are again well and in a natural condition. Washing the hands in very dilute carbolic acid water will alleviate the pain somewhat and hasten the healing by neutralizing the cyanide. When it is necessary for the plater to have his hands in cyanide solutions from time to time, or to handle work that is saturated with the solutions, it would be well to have a jar of acidulated water, composed of eight ounces of sulphuric acid to each gallon of water, close at hand so that the hands may be plunged into it from time to time, thus destroying the effects of the cyanide before it has had much time to penetrate the pores of the skin. A better plan is for the plater to wear rubber gloves, where this is practicable. The greatest drawback to the gloves is the fact that they are easily punctured and, if worn in a leaky condition, are worse than no gloves at all. The punctures, however, may be easily and quickly repaired by the use of a little rubber cement.

The system being poisoned from contact with cyanide, mercury dips, or copper solutions, often causes the breaking out of boils, or abscesses, upon the limbs or body, or both. The writer once had a finger badly lacerated upon an emery wheel; while in the process of healing the dressing upon the wounded finger became saturated with cyanide of copper solution; the arm and hand became badly swollen and were very painful; finally a boil appeared upon the hand; then two came upon the arm, with several others upon the back and other parts of the body. While undergoing treatment for this disability, my physician strongly advised me to give up the plating business, in order to regain and retain my health. This I did for a few months, but soon returned to my old work. Plating seems to be like sailing. "Once a sailor, always a sailor."

Caustic potash which is used so extensively for cleaning purposes by the plater, is also a poison to some constitutions, and in any event is a medium which materially aids cyanide, mercury or copper solutions to enter the system and produce all kinds of blood troubles. The other potassiums and oxalates are also more or less poisonous. Potassium poisoning varies greatly with the victim. In some instances only certain portions of the hands or fingers seem to effected, while in other cases the whole arm may be seriously poisoned and a case of blood poisoning ensue. In the majority of cases, the first symptoms are intense itching of the back of the fingers, followed in a few hours by minute water blisters. If treatment at his stage is resorted to and work suspended for a few days the hands readily assume their normal condition, but once the workman receives this warning and does not take precautions, a second, third, and fourth attack are sure to follow, each a little worse than the previous one. In the second attack the blisters are larger and the itching more intense; the blisters break, leaving raw patches which heal very slowly. In the third and fourth attacks, the skin begins to thicken and after the blisters have disappeared begins to crack open and peel away, leaving raw spots and incapacitating the workman from doing any work which involves the use of his hands. As soon as a plater finds these symptoms coming on he will do well to go to his druggist and have the following prescription put up:

Syr. Ferri Iodide	6 dr.
Syr. Sarsaparilla	2 oz.

Dose: A teaspoonful after each meal.

To allay the extreme itching, the hands may be held in a bowl of tepid water and C. P. carbolic acid. A teaspoonful of acid to the quart of water. This bath may be saved and the hands immersed in it from time to time. Care should be taken to stir the bowl with a spoon before plunging in the hands as the acid sometimes has the tendency to separate and sink to the bottom, and unless stirred will burn the fingers. Resinol is a prepared salve which can be had in almost any drug store, and which has a tendency to draw the poison from the fingers and keep back inflammation. This should be applied freely to the affected parts, and the fingers bound up for a few hours until all inflammation has disappeared. When the following ointment which is a skin grower and aids in producing a normal tissue should be applied:

Aristol	½ dr.
Sterilized Olive Oil	2 dr.
Vaseline	2 oz.

This skin food should be freely applied to the hands and fingers before retiring for the night and a pair of loose cotton gloves pulled over the hands. Where the skin is abnormally thick, this food softens it and penetrates the crevices, helping to form good healthy underlying tissue. Without a skin food, the skin is apt to remain so very thin that it breaks with the slightest pressure. During troubles of this kind, all soaps which contain alkali must be abandoned, and where necessary to use soap at all something of the nature of Cuticura soap, surgeons' green soap or pure Castile only should be used. It would be much better, however, to avoid the use of all soaps for the time being.

Cyanide fumes also affect the general health of platers, in time, where there are large quantities of strong cyanide used, with insufficient ventilation of the plating rooms. This, however, takes some time, and where the plater will use care in doing his work and refrain from handling cyanide in any form any more than is absolutely necessary, at the same time keeping the room well ventilated, so that he will inhale as little of the fumes as possible, observe the laws of nature concerning his everyday life, be temperate and of regular and proper habits, he will probably escape most of the evil effects common to most platers.

Some of the common effects of inhaling cyanide fumes are a loss of appetite, bitter taste in the mouth; dryness of the throat and nose; swelling of the passages in the head; soreness over the eyes, and a languid, tired feeling. This may go on for some time without appearing to grow any worse, if no rest is taken. Then the sufferer is liable to attacks of dizziness, being unable to stand at times; then vertigo and vomiting may follow. These spells may come on every week, or oftener. When the plater gets into such a state of physical weakness that it is liable to have serious effects upon his future health, and also interferes with his work, he should by all means take a much needed rest.

Very strong cyanide fumes, when inhaled in large quantities, as, for instance, when a new solution is being made, or a large quantity of cyanide dissolved for any purpose, will often cause a fluttering of the heart, making it difficult to breathe. In this case the plater should go immediately into the outer air and inhale the fresh air by taking deep breaths, expanding the lungs and driving out the poisonous fumes. The digestion is also sometimes affected by the different gases parching the mouth and throat, thus drying up the saliva that should go into the stomach to help digest the food. The fumes from lacquer and lacquer thinner have a very drying effect upon the mouth, throat and lungs.

Where cyanide solutions are used in large quantities, hooks and tongs, long enough to reach to the bottoms of the vats, and suitable for removing any pieces of work that may drop to the bottom, should always be at hand. They should be used instead of the plater, or his assistant, thrusting his arm into the poisonous solution; platers do this entirely too much. When a piece falls to the bottom of the vat, it is much quicker to reach the hand in and get it out than to fish for it with a hook or tongs. While no evil effects are noticeable at the time, still a continuation of this practice is bound to bring retribution sooner or later. It is only reasonable to suppose that, as the pores of the skin absorb the cyanide every time the arms come in contact with it, cyanide being very penetrating, it is only a question of time when evil results will follow, depending upon the frequency with which the poison is allowed to come in contact with the body and the amount absorbed. Much depends also upon the habits of the individual and his physical condition. All these things have a bearing upon the result, either for good or for evil, and so they are worth consideration.

Platers who are closely confined, or who work in poorly ventilated rooms, should take as much out of door exercise as possible, and make a practice of inhaling good, fresh air freely, always sleeping with a window open when the weather will permit it. Exercise that is calculated to stimulate a good circulation of the blood is of much value, as the action of the fumes common in the plating shop has a tendency to cause a sluggish circulation.

Plenty of good, wholesome and blood-producing food should be taken and the plater should drink freely of water and milk. Many platers are addicted to strong drink and nearly all of them to the use of tobacco, and almost without exception, if asked for a reason for it, the answer will be that they think it is an aid in counteracting the acid or cyanide fumes, as the case may be. This is a mistake, but it is generally used as an excuse and I believe that some platers really think that they could not get along without their regular dram. The fact is that any alcoholic beverage not only does not counteract cyanide poisoning, but, if anything, aggravates it. Cold baths, followed by brisk rubbing with rough towels, will stimulate the circulation of the blood, thus aiding the system to throw off any foreign matter which may be in the blood.

For platers who are working over strong cyanide solutions continually, a Turkish bath, or vapor bath, once a week is valuable where the system has become saturated with cyanide when the bather begins to sweat freely in the hot room, a distinct odor of cyanide can be readily detected, thus proving beyond a doubt that the cyanide penetrates the system and that a good sweat bath will remove a part of it at least.

Care should be taken to avoid drinking from vessels of any kind that are used for dipping or handling solutions or acids. It is a dangerous practice. You may, perhaps, rinse the dish thoroughly before you drink, but some day you will be in a hurry and forget to do this. Then, others, not being acquainted with the nature of the dangers lurking about the plating room, and seeing you drink from this same dish, may, at another time, drink from it without first rinsing it. This has often caused very serious and sometimes fatal results. It is a good plan to have the drinking cup fastened by a chain to the drinking faucet, to have it always in place when wanted, thus preventing its use for anything else and also avoiding the necessity of drinking from any other vessel.

In using potash, lye, caustic soda, or any other strong alkaline solutions in removing grease or cleaning, avoid as much as possible having the hands come in contact with the solution, as it readily attacks the skin and dissolves it. It also affects the nails to a considerable extent. Where it is necessary for the hands to come in contact with these cleaning compounds, it is advisable to have near at hand a jar containing very dilute sulphuric acid; or a little nickel solution will answer the same purpose. It is very difficult to handle work on wires when the hands have been in contact with any alkaline solution, such as cyanide or potash, so that it will be found advantageous to dip the hands into the acid water, or into a little nickel solution. This removes from the hands the slippery or slimy coating caused by the alkali dissolving the skin and allows the work on wires to be easily handled.

Cyanide taken internally, even in very small quantities, usually proves fatal at once. If the victim still retains life, peroxide of iron and potassium carbonates should be given at once and the coldest water, or ice, if available, should be applied to the back of the head and to the spine.

Sulphuric, nitric or muriatic acids, if taken internally by accident, should be treated by giving the patient carbonate of soda or magnesia, dissolved in water.

Potash or other alkalies accidentally swallowed, require a few drops of sulphuric acid in water, or a drink of vinegar or tartaric acid.

If poisoned by arsenic, the victim should be made to vomit immediately, by thrusting the finger down the throat. Then give freshly precipitated ferric hydrate and calcined magnesia mixed with fifteen times the quantity of water. Give a swallow of the mixture every few minutes until relief is experienced.

For lead or copper salts, give a few drops of sulphuric acid in a glass of water, or give him lemonade or bichromate of soda.

The best remedy for cyanide sores upon the hands, when it is not convenient for the plater to take a rest in order to allow the sores to heal, is to apply a piece of shoemaker's wax to the sore, first heating it until soft and then dropping it upon the sore and pressing it on smoothly, when it should be allowed to cool and harden. This will withstand the action of the cyanide and protect the sore, giving it a chance to heal.

If the plater will use ordinary care to keep his rooms well ventilated and watch himself closely and continuously, he will be likely to have little trouble; but most platers do not learn this until they have had one or two severe frights and an occasional spell of sickness. In the plating room, as in railroading, a moment's carelessness may cost a life, and the beginner should know it in advance.

CHAPTER III.

THE POLISHING ROOM ITS MACHINERY AND MANAGEMENT.

One of the commonest mistakes made by inexperienced persons who are embarking in the plating business is in laying out the plating rooms as conveniently as possible with the space at hand, without taking into serious consideration the amount of space and light required in the polishing department. Such persons will usually give this very important branch of the business any space that may not be necessary for other work, while, as a matter of fact, the polishing and buffing room should be given the preference in the matter of space and light; and this latter course is always followed by those who are experienced sufficiently to know the value of sufficient room for handling the required work and also the absolute necessity of a good light in order that polishing may be properly done rapidly and cheaply.

Of course the amount of floor space and the arrangement of the polishing machinery in the room will depend entirely upon the class of work to be handled. Large work, such as flush pipes, tubing and other plumbers' supplies, also railings, large panels and other bulky pieces, either of brass or iron, require sufficient room about the polishing lathes to handle the work freely and easily, without interfering with the workmen at the adjacent machines. The room space should also be large enough to permit of turning end for end any piece of work you may be called upon to do.

Smaller work, such as cutlery, bicycle trimmings, hardware and small brass goods, do not require as much floor

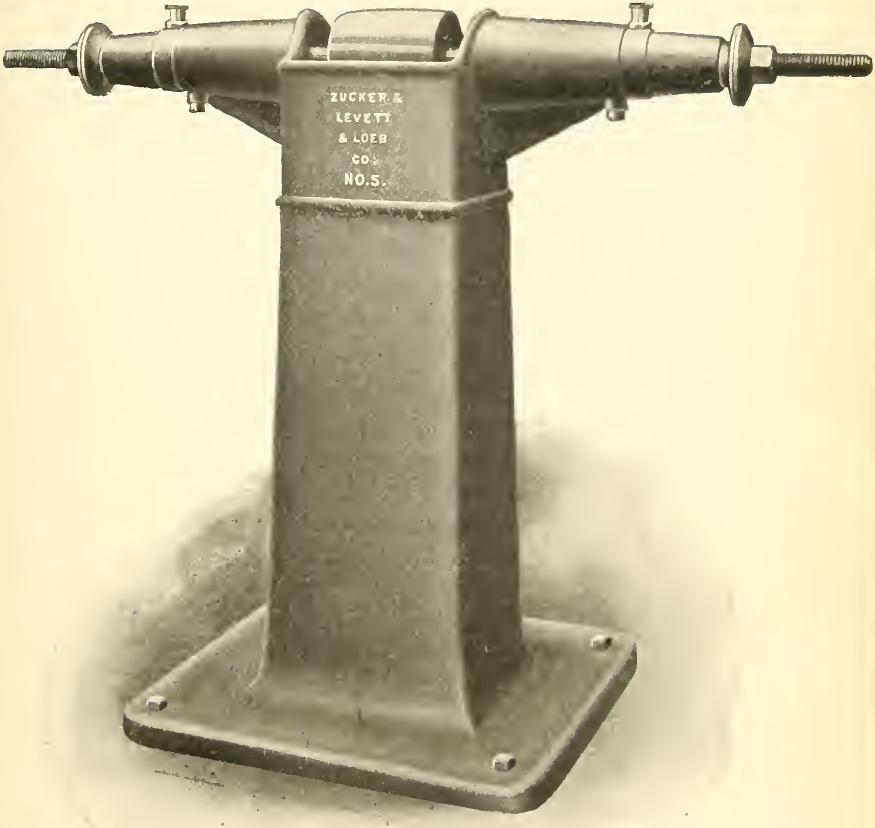

Fig. 1. Heavy polishing lathe with 51-inch spindle, with tubular bracing along the spindle.

space for polishing, as there are no large pieces to turn about and move in several different positions while being polished; therefore the polishing lathes may be set much closer together and also have much less room at their fronts and backs than could be permitted if there were a liability of frequently receiving long and large pieces to be polished.

It is a fatal mistake to fit up a plant for polishing and plating of any kind without considering the polishing as of the first importance, for unless the work comes to the plating room properly polished and highly finished, first-class work cannot be expected in the plating or the finishing of the work. Of course each plant will have to be laid out as best suits the amount of room and light available, considering the class of work to be done and leaving as much margin as possible for those occasional large jobs that may come to you because the other fellow cannot polish them properly at a profit.

In large manufacturing or jobbing plants, where large quantities of rough work are handled, such as brass or iron castings, plates or stampings, it is usual and quite necessary to have the grinding and polishing done in a separate room from that in which the buffing and finishing of the plated work is performed, as when both operations are done in the same room the small particles of metal and emery from the grinding and polishing wheels will fly about the room and become lodged in the buffing wheels, on the work to be buffed, or on the buffing compound, causing the work to be scratched while being finished. This should always be avoided when possible, as it detracts much from the appearance of the finished work if allowed to go out, or causes unnecessary expense and delay if the scratches must be polished out again, besides rendering the buffs and composition unfit for fine work, on account of the difficulty of cleaning out the coarse particles from the buffs when they have been allowed to get into them.

In fact, in any large and well arranged plating establishment, there are four departments which should be separated by partitions of wood or glass, or both, namely: the grinding and polishing room, the buffing room, the plating room and the lacquering room, if a class of work is handled that

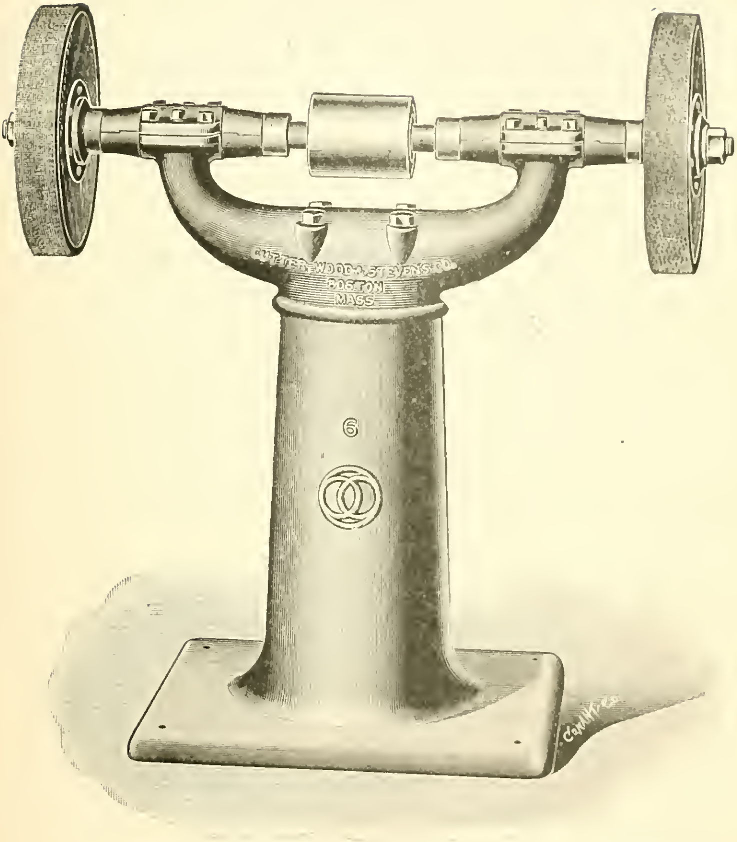

Fig. 2. Polishing Lathe, with 45-inch spindle and heavy arched bracing and boxes.

requires lacquering. This is not meant to be laid down as a necessity, but as indicating what should be the arrangement of a well appointed shop turning out large quantities of first-class work. Of course, for the great majority of small shops, this would be too great an expense to incur, particularly in cities, where rents are high; so these shops usually content themselves with two rooms, a polishing room and a plating room, preferring to take chances on getting the work out in a satisfactory manner, rather than incur the expense of partitions and larger rents.

Some shop owners are so careless, or lacking in professional pride, as to attempt to do the polishing, buffing, plating and lacquering all in one room—and a small room at that. Where this practice is indulged in, good work is next to impossible, as the lint from the buffs, the flying rouge and emery dust get into the plating solutions and on the lacquered work, causing no end of trouble. Unless the plant is very small and the amount of work to be done is limited in quantity the several departments should be separated by partitions with close fitting doors.

The machinery in this, as in every progressive business, is changed and improved from time to time, and it is always a mistake to purchase any but the latest and most improved machinery in fitting up a plant, as the cost of doing work depends very largely upon the means for doing it, and a less cost on your work always means that you can work at a profit where your poorly fitted competitor will make no profit, or even a loss. We do not advocate low prices in the plating business, but there always has been and always will be price cutting when work is slack, or when a new competitor enters a field in which there is insufficient work to keep the new establishment fully employed without trenching upon the business of the older establishments; then, too, there is the shrewd buyer, who is always looking for a chance to reduce costs, and he usually does it by manipulations that will start competing platers to cutting prices. In such a case it is always the best fitted shop that starves the other out, and if such games are tried on you, you may have cause to be thankful that your machinery is all new, of the latest patterns and well adapted to its purposes. While the patterns may vary, certain characteristics are to be found

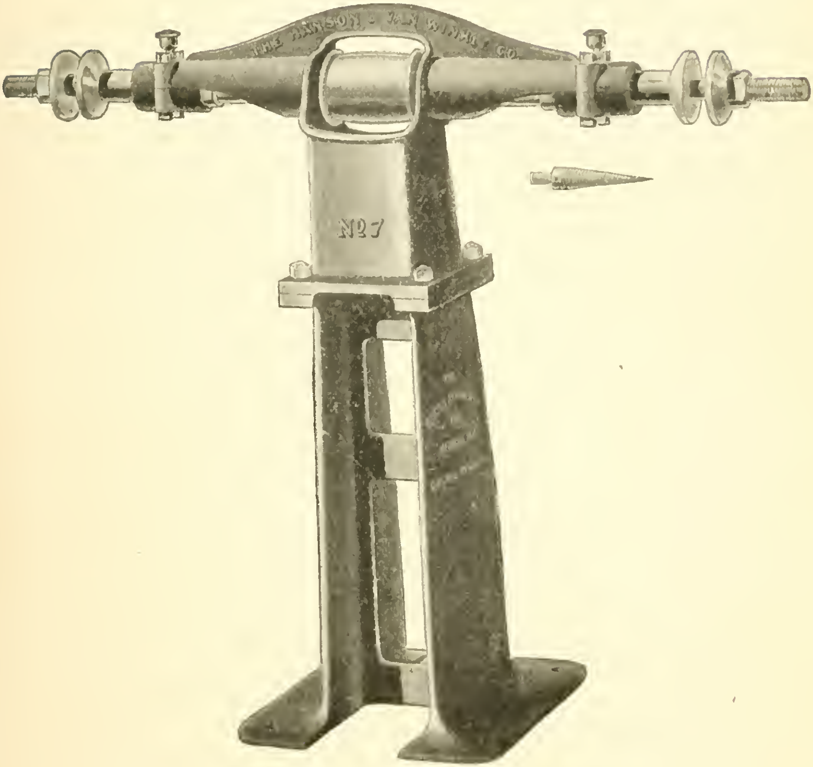
THE HANSON & VAN WINKLE CO.
No 7

Fig. 3. Polishing lathe with 52-inch spindle, mounted on hollow column and braced across the top.

in the goods of all manufacturers, and we desire to have it understood that we do not mean to indicate that the illustrations used in this connection were chosen as the only ones that are worth purchasing, but only that they will serve as types of their special classes and illustrate the requirements of the machines which should be purchased in fitting up a plating and polishing establishment that is to take its place in the market, fitted to fight for business as all concerns frequently must do.

Polishing lathes should be selected that are best adapted to the class of work to be done. For large, heavy work, where large wheels are to be used and considerable pressure is put on the wheel by the operator in removing scale, sand holes, etc., from castings, polishing heads should be selected that are made particularly for strength and durability. They should be mounted on cast iron posts or pillars capable of being well secured to the floor and should be well braced along the spindle from bearing to bearing. The flanges or collars at each end of the shaft should be set close to the bearings, thus allowing the machine to carry without springing, wheels of a size and weight that would be impossible without a system of bracing as illustrated. Boxes should be adjustable to take up wear. The whole construction of this machine should be calculated to make it firm and rigid under the heaviest strain; at the same time it should be built in such a manner as to leave plenty of space to handle and turn the work below the wheel.

Then there is the overhanging or projecting lathe, which carries its wheels or buffs farther out and away from the post or column upon which the head is fastened than is done by any other form of polishing lathe. This machine is valuable for special work, or for any large work requiring plenty of room, such as large pieces of sheet metal, pipe, rods, brackets, chandeliers or brass beds, or other articles. From these heavy machines the lathes on columns range down through various sizes, from those sufficiently heavy and strong to run wooden polishing wheels up to 16 inches diameter, to those adapted to carry buffs 9 or 10 inches in diameter at 3,000 revolutions per minute; then on to the light polishing head, adapted to run on a bench, without a countershaft. The various classes of spindles shown separately may be fitted in most of these lathes. Then there are the foot-power machines, and the electric, or motor polishing head. The latter is very neat and serviceable for

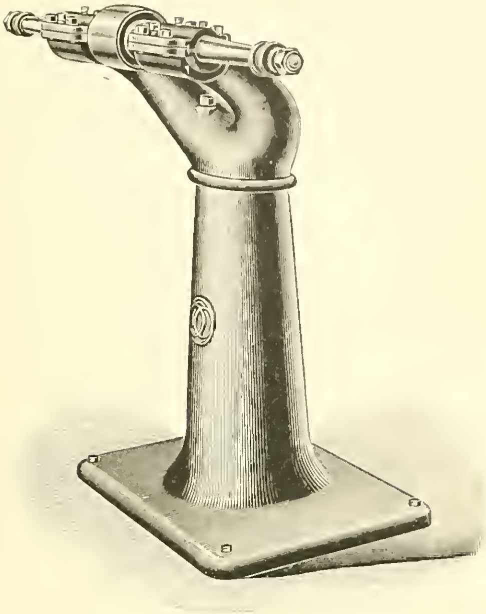

Fig. 4. Overhanging polishing lathe with slender arch neck and 48-inch arbor. A popular type.

the smaller classes of work. It requires no belting or countershaft, which is frequently a big item; it can be run at any desired speed, having a lever to increase or reduce the speed at will; it is practically noiseless, and it may be set up and run wherever electric lights are used. When not in use all expense ceases; there are no rattling countershafts to keep oiled and no greasy belts to scatter dust and dirt about the room. The first outlay in fitting up with these machines is considerable, but their advantages are such that they must come into extended use in the lighter shops in cities, and also in the newer plants for heavier work that are being fitted up with electric distribution of power. Larger sizes of this machine are now being made with ring oiling bearings and regular connections for power circuits. The man who puts them in should bear in mind that polishing lathes generally use from three to five horse power, and make his electric installation accordingly.

The twin lathes are a novelty which are finding their way to a limited extent in some large shops. This machine consists of two single ended shafts, mounted in one stand, the idea being to permit one workman to stop for any purpose at will, without interfering with the other. This pattern has extended use in some of the large shops in Cleveland, Ohio, but does not seem to be received with much favor by proprietors generally, because the extra cost of the pulleys, belts and countershaft make the advantage gained in time of questionable value financially.

Very small shops, which do not have much work on many wheels, sometimes use lathe spindles with two flanges on each end. In this case all four wheels are mounted on the one lathe, which saves the extra expense of buying an extra lathe and some floor space. The practice is not to be recommended, however, except as a necessity when starting a small business.

Foot power polishing machines are made in several different styles, of which the one shown is a type; but they are not to be recommended, except for very small plants, and for the amateur, or where no other power is available, as doing polishing of any kind by foot power is hard work, slow and unsatisfactory in every way and the plater will find that he can put in his time more profitably soliciting enough extra work to pay for the power he uses in polishing rather than attempt to economize by doing his work without power, even if his plant be a very small one.

The foot power polishing lathe was never intended for the plating shop, anyway; it was designed for buffing watch cases in country jewelry stores, rings and such other jobs as come to the country jeweler, where the lathe will probably not be used over once or twice a day on the lightest

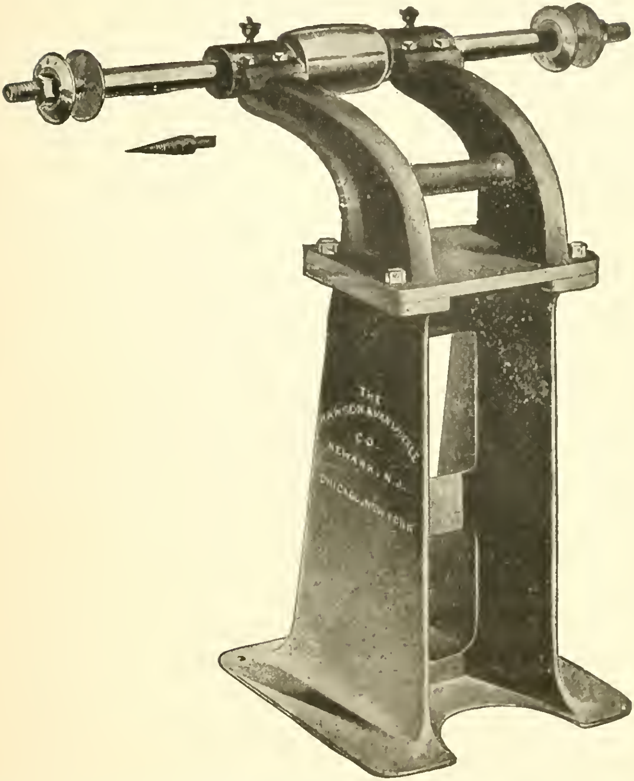

Fig. 5. Overhanging polishing lathe on open column with arched spindle bracing, 42-inch arbor.

kind of small work. It is kept in stock by dealers in polishers' supplies who have the trade of jewelers and is never sold to platers, except as a makeshift, which is intended to be displaced by a power lathe as soon as the plater can raise the money to buy one.

Then there is the flexible shaft, which is a machinist's device that has been very successfully adapted to the polishing room. The wheel or buff is attached to the spindle at the end of the flexible shaft, hand holds being arranged on each side of the wheel, so that the operator may easily guide it, instead of guiding the work as he does on an ordinary polishing machine. By the use of this machine, large pieces that would otherwise have to be handled with ropes, chains and pulleys (being too heavy to be handled by hand) may be polished by laying them on the floor, with space enough to get around them, and working them down with the various wheels and buffs in succession. Large work of peculiar and inconvenient shape may also be polished with this apparatus quicker and consequently at less cost.

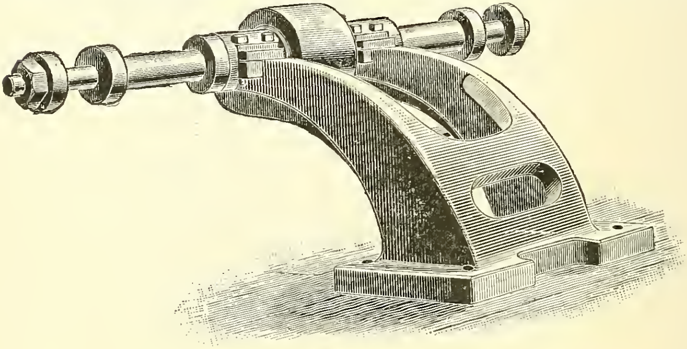

Fig. 7. Overhanging polishing lathe for bench or column as desired

The belt strapping attachments shown are simple in construction and easily operated They are designed with a view of meeting the requirements of the large variety of work which experience has shown can be economically and rapidly polished or roughed off by this method The facility with which these machines can be operated make them applicable for many small articles heretofore polished on regular wheels, on account of the ease with which the work may be handled on belts and the much greater working surface of the belt as compared with the circumference of a wheel,

These belt machines can be used to great advantage by manufacturers of bicycles and bicycle parts, brass cocks, and other plumbers' fittings, gas fixtures, grate and fender work, while for cutlery they seem to be indispensable, as with no other device can the operator reach as well all sorts and conditions of metal surfaces that are inaccessible with the regular polishing wheels.

In operating them, the flanged driving pulley is placed on the end of a grinder head or polishing lathe spindle. The upright supporting the smaller pulley is designed to be set up at a point that will admit of using standard length belts, but this may be increased or diminished at the discretion of the user. The upright support is screwed securely to the floor, as is also the adjusting arm. In changing the belt the operator merely presses his foot on the lever, which will release the dog from the notched adjusting arm, moving the upright slightly forward, after which the belt can be instantly removed or replaced. The upright is then drawn up until the proper tension is reached, where it is automatically locked. Any stretch in the belt is readily taken up by the adjustment.

The bench machines shown are designed to be operated in the same way, except that they may be driven from polishing lathes which are mounted on benches, and they have extended use in shops which handle much small work.

Electricity has recently been applied also to the flexible shaft. A small motor, mounted on a light truck, being used to rotate the shaft, while connection is made to the motor by means of a lamp socket and flexible cable. This portable outfit has been used in many of the large stores and office buildings in the cities as a means of polishing signs, railings, door plates, hinges, lavatory fittings, exposed plumbing and any other metal surfaces or fixtures that can be gotten at readily without removing them. This reduces the janitor force and wage account by doing away with most of the hand polishing, which in large buildings requires the entire time of several men for this purpose alone.

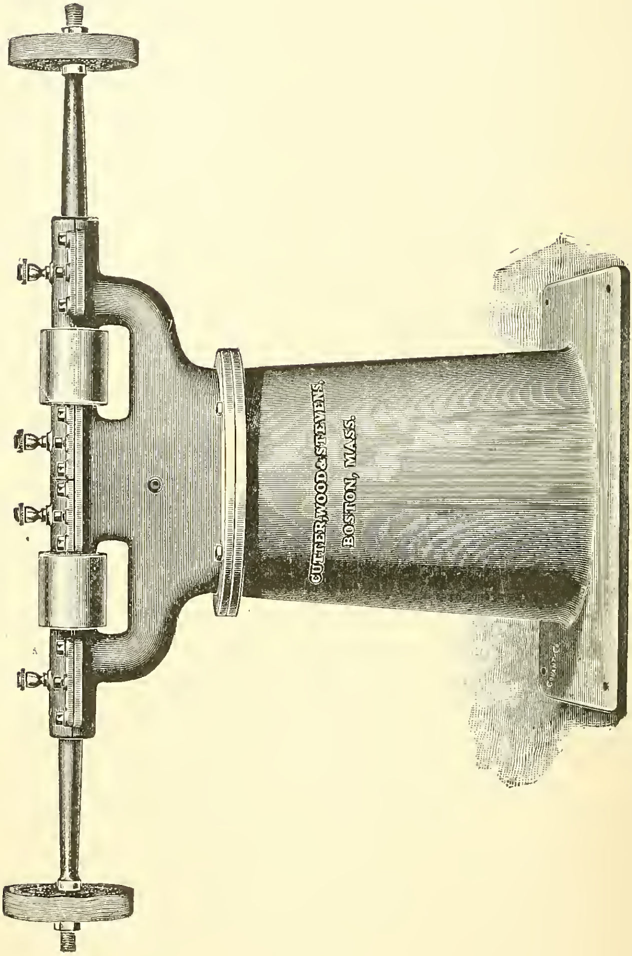
CUTTER, WOOD & STEVENS,
BOSTON, MASS.

Fig. 6. Twin spindle polishing lathe on iron column.

In some large and up-to-date shops the motor system of driving machinery has been adapted to the polishing room with considerable success. This system gives many advantages which are of importance to a large plant; the chief of these is that power is being consumed only while work is being done, as electricity responds so quickly to any resistance that the power consumed instantly rises when resistance is encountered and as quickly falls off when the wheels are running free. If we consider how much of the time the work is held away from the wheel, even when polishing, this gain will be seen to be enormous. It also allows greater freedom in the location of the polishing shop, as wires to feed the motors may be run anywhere at any reasonable distance, without serious loss of power, as would be the case if belts and long lines of shafting were used to carry the power. The current may be carried through stores, salesrooms or offices in a cleanly and effective manner, which is not the case with shafting. Additional power may be cheaply and quickly added electrically and a prosperous business is always wanting more power in the polishing room, as any superintendent of a large plant will cheerfully testify. These are some of the reasons why the electrical system of driving is making rapid headway in large plants.

The electrical system of driving also has the advantage that one may start in a small way and keep on adding motors as more power is required, as it has been found that it is cheaper to add another motor with each new group of lathes than to take them out and replace with larger ones when more power is wanted; in fact, the more motors the better, as far as consumption of current is concerned, because the more motors you have the less shafting there will be and the fewer belts. It is in doing away with shafting and belts that one of the chief gains is made by the electrical system. Consequently one need never sell a

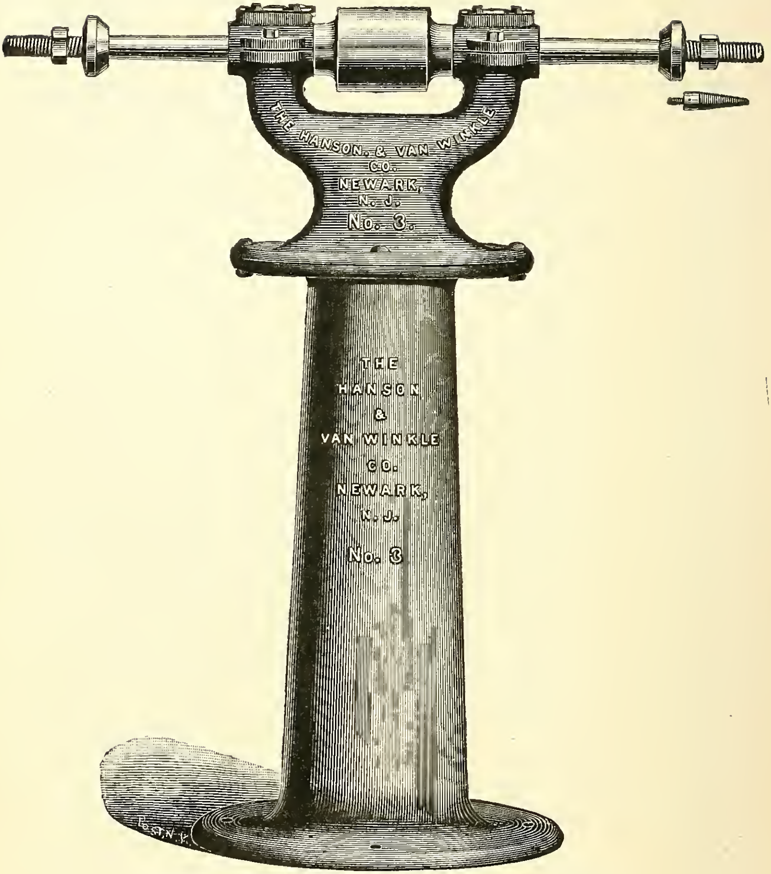
THE HANSON & VAN WINKLE CO. NEWARK, N. J. No. 3.
THE HANSON & VAN WINKLE CO. NEWARK, N. J. No. 3

Fig. 8. High speed buffing lathe, with long spindle.

motor for less than it cost, but simply keep it and buy another for the additional power that is needed.

The direction and amount of light available for each workman should always be the first consideration in laying out the arrangement of any polishing room, whether two or twenty lathes are to be used. Each workman should face the light, if possible, so that he may at all times see

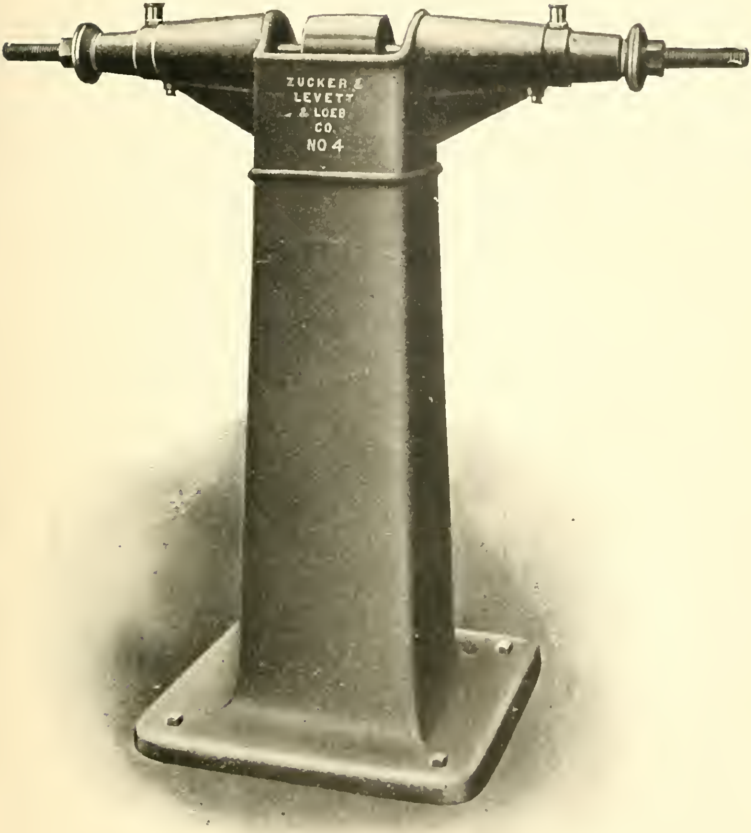

Fig. 9. High speed buffing lathe with tubular bracing for spindle.

exactly what he is doing without having to leave his machine or turn around to examine his work. No polisher can do good work and do it quickly with a poor light, and as the price of labor is the chief item of cost in any polishing room, it behooves the management, especially in large plants where many men are employed, to make the best possible use of the available light.

Suction fans, or exhaust blowers, should be provided in all polishing rooms, even when only one or two polishing lathes are to be used, as they are a great help to the polisher in keeping things clean and in making the air of the room fit to breathe. Hoods should cover each wheel and be connected by large metal pipes to the main exhaust pipe of the blower, so that the lint and dirt from the wheels may be drawn into the blower, thus keeping things clean and adding greatly to the health and comfort of the polishers. In most of the states the law requires the use of blowers in

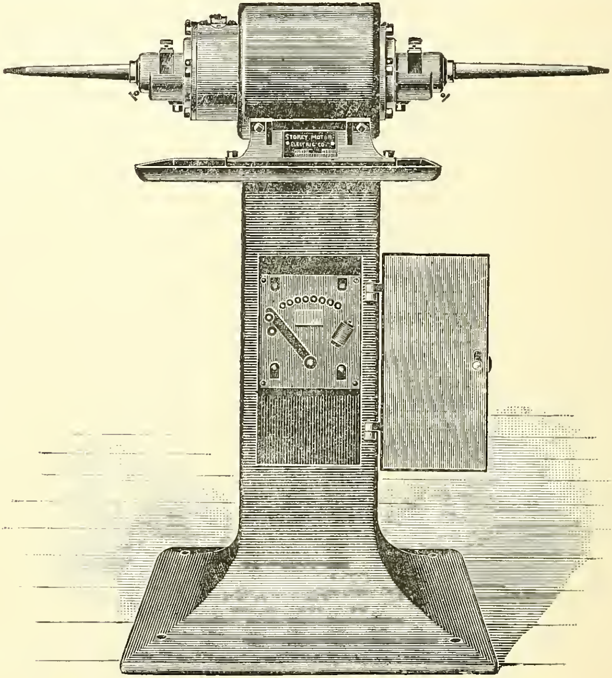

Fig. 10. Electric motor lathe on column, with starting lever and rheostat in column.

all polishing rooms, and it is a law that should be rigidly enforced. The greatest trouble in the use of blowers is that they are generally too small for the work which they are expected to do. Then, too, they are very often improperly set by inexperienced men (in the effort to save a dollar) and do not give satisfaction. The funnels or hoods from the blower pipe should be wide enough and come close enough to the wheels or buffs to draw in all dust and lint that is made while working. Screens of wire of a rather coarse mesh should be fitted into each hood where it tapers down to enter the pipe whenever small work is to be polished. These screens will prevent the work from being drawn through the blower, should it slip from the hand while being polished, as this would very likely damage the work and might injure the blower if the piece drawn into it were of considerable size.

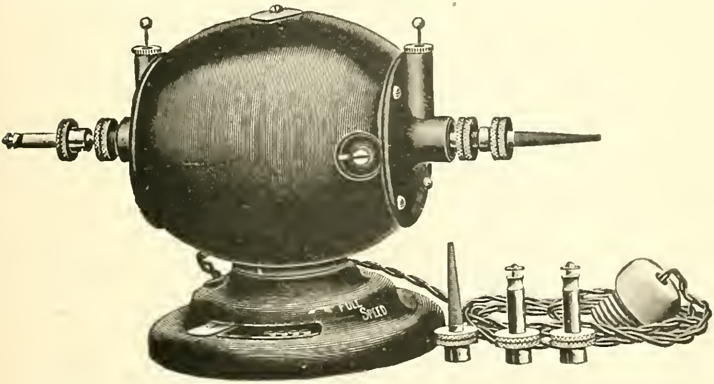

Fig. 11. Electric motor lathe, with starting switch in base and plug connection to lighting sockets.

Oiling the machines is another item that is very often given too little attention in the polishing room. All bearings should be oiled daily; sometimes twice a day is better. All oil cups, when possible, should be provided with covers in order to keep out particles of emery and metal, which

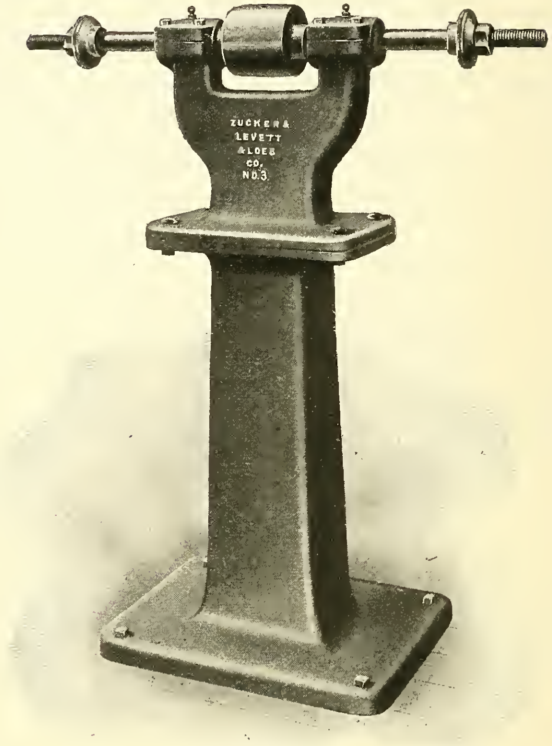

Fig. 12. Light buffing lathe for general purposes.

if allowed to penetrate into the boxes will imbed themselves in the babbit or other soft metal of the boxes and soon form a regular lap, such as machinists use in working hardened steel. When this happens the spindles are, of course, soon cut so badly that rebabbitting is necessary; if they are allowed to cut very frequently, you will soon need a new spindle. Cotton waste should be placed in the oil cups wherever possible, and it should be changed whenever it gets dirty, thus catching and removing the grit before it can enter the bearings. Cotton batting, being finer, is preferred by some, as it makes a better filter for the dirt.

Countershafts in the polishing room seldom, if ever, receive the attention they should have in oiling. This work is usually given to some careless or inexperienced person, who usually finds it an unpleasant and difficult task, if done properly; so, as a general rule, the oil is poured on the box rather more than in it, thus soon causing loose and noisy countershafts and spindles of the lathes.

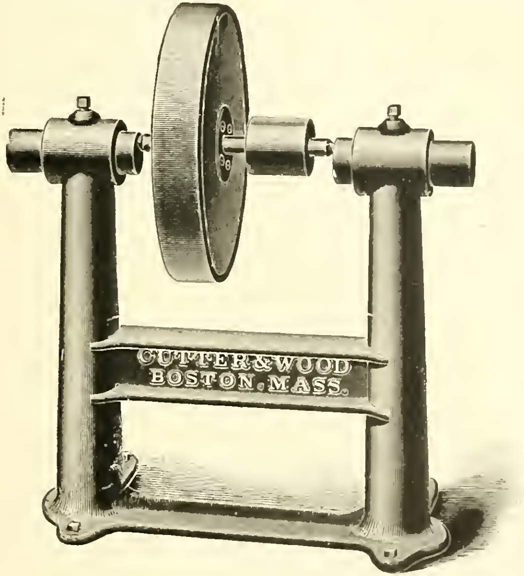

Fig. 13. Cupola lathe, or dead center lathe, which has extended use among cutlers, gun makers, etc.

Emery Wheels.—Emery or corundum wheels are used principally for removing the gates or spurrs from castings and any other rough places which may have been caused by a greater or less breaking away of the sand in the mould before the metal has been poured into it. They are made by taking a sufficient quantity of the sifted powder, mixing it with a cementing material,

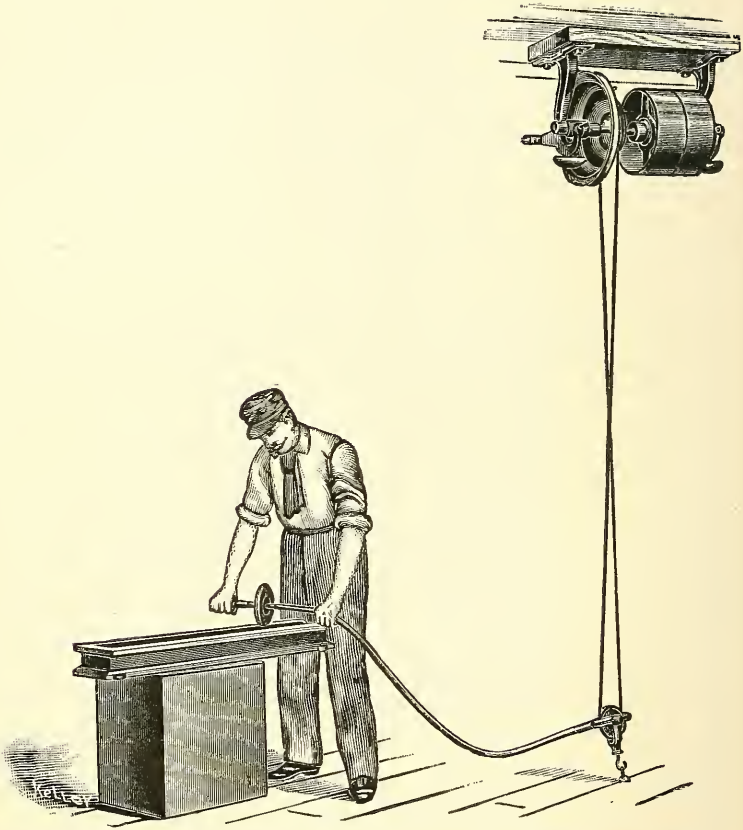

Fig. 14. Flexible shaft for grinding and polishing heavy castings.

called a bond, pressing the mass into moulds under great pressure, and then baking the wheels thus made until they are thoroughly dry. The wheels are designated in the same way as the powdered emery or corundum from which they are made; thus, an 80 wheel is one that is made from No. 80 emery powder, etc. Different manufacturers use different bonds, and the wheels will vary slightly in their adhesive powers and the facility with which

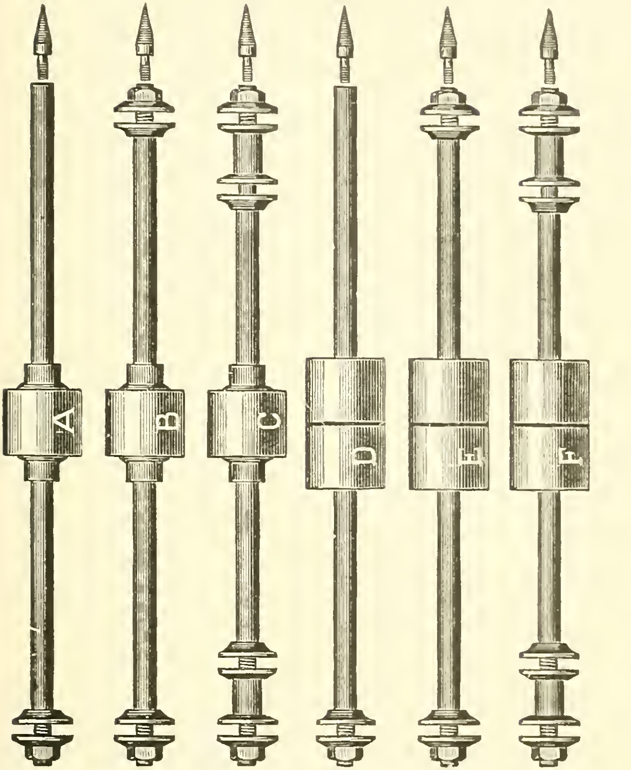

Fig. 15. Spindles of various types as used in polishing lathes.

they will glaze over when used with too much pressure or too much speed; they will also vary in the extent to which they will soften and break or crumble, if they are unduly heated by being run too fast, or with too great a pressure of the work upon the wheel. When this is the case some one is liable to get hurt. I have seen part of a large emery wheel go through a twenty-inch brick wall, after bursting, and I can assure the average polisher that he is likely to get into the hospital, if he does not use due care in handling his emery wheels. I have been thus explicit because I

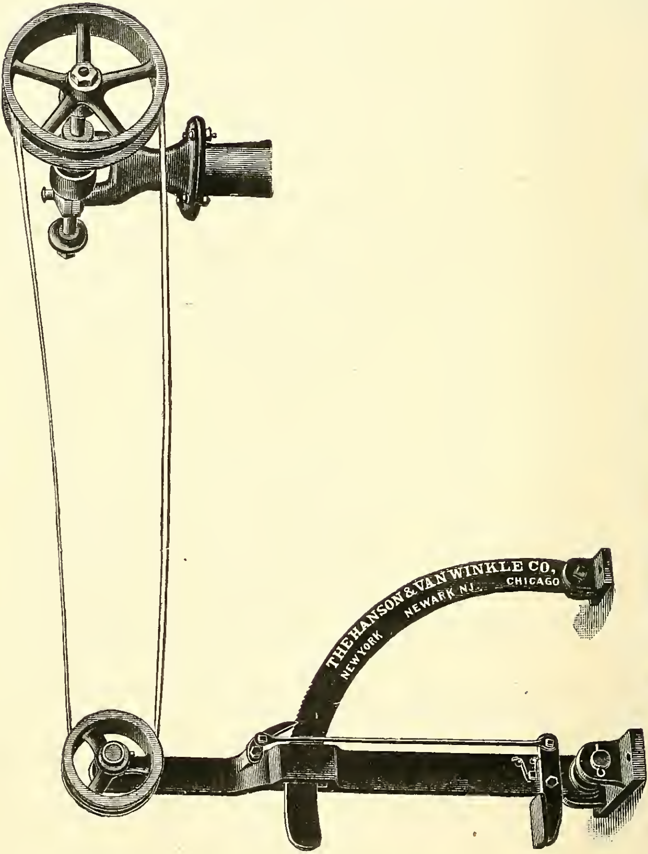
THE HANSON & VAN WINKLE CO,
NEW YORK
NEWARK N.J.
CHICAGO

Fig. 16. Belt strapping machine for standard length belts.

find that many polishers and machinists think that their emery wheels are a natural stone, quarried out and turned into shape, and also because they do not understand the real danger that exists in running wheels too fast and the differences between wheels of different makes, or even of two wheels from the same maker. All makers of emery and corundum wheels publish tables showing the safe speeds at which their wheels may be run and it is never safe to exceed these published speeds. This applies especially to the larger wheels. These wheels should always fit the spindle snugly, so that they will have a true balance and great care should be taken to see that the wheel is firmly and securely fastened before starting to work with it. When large emery wheels are used, it is a good plan to fit a rubber or leather washer on each side of the wheel, between the wheel and the flanges; the washers should be a little larger than the flanges, so that when the nut is tightened the pressure of the flanges does not come directly upon the wheel, but upon the intervening washers, thus reducing the liability to crack or injure the wheel from the pressure.

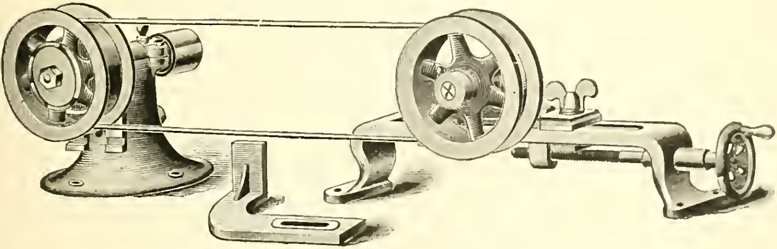

Fig. 17. Belt strapping machine for benches.

It is also dangerous to allow large emery wheels to get out of balance while in use, by becoming gouged out or worn off in spots.

An emery wheel dresser should always be at hand to turn down the wheels in order to keep them balanced. It is also required to turn them down a little when they become glazed, which they are liable to do when they are run too fast, or with too heavy pressure; or when used continually they must be occasionally dressed off with the emery wheel dresser. In using this tool keep it well oiled. Run the wheel at its regular speed, set the rest firmly about level with center of the wheel, and far enough from it so that when the claws of the tool are hooked over its inner edge, the points of the cutters will not quite touch the wheel when the tool is held level. Bring the cutters in contact with the wheel by firmly and gently raising the handle of the tool as the high and uneven pieces are cut down.

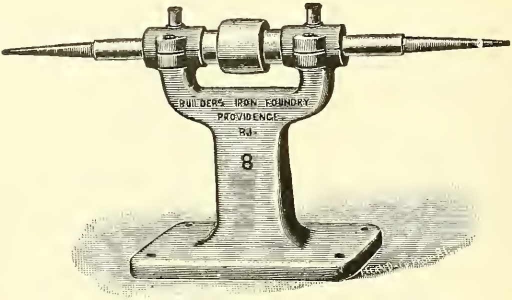

Fig. 18. Light Polishing Lathe for Bench.

In using the tool, pass or slide it slowly back and forth against the wheel, using less pressure when cutting down the corners or turning to a sharp bevel.

If the wheel is glazed or slightly out of true, only touch it lightly, or the fast cutting of the tool will unnecessarily waste the wheel.

Hold the tool in such a manner that the cutters will revolve with the wheel and in line with its motion. If fire flies, it is a sure sign that the wheel is grinding away the points of the cutters, because of their running with want of oil, or an improper position of the tool. Emery wheel dressers and diamond turning tools are usually kept locked up, in charge of the foreman, to prevent undue waste of the wheels.

In grinding castings, especially small ones, which heat quickly from the friction of the wheel, a tub or pail of cold water should be at hand, into which the castings may be immersed from time to time, until cooled, when the grinding can continue.

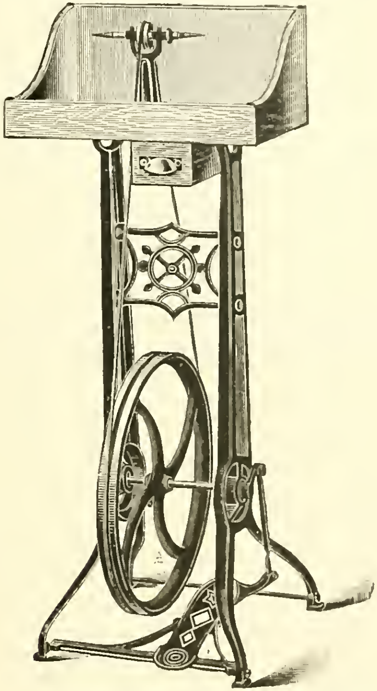

Fig. 19. Foot Power Polishing Lathe.

In grinding rough, heavy castings, the first operation is usually upon a coarse, solid emery wheel which is run at a slow speed, not more than 1,000 revolutions per minute. This wheel is used mostly for removing gates of castings and burrs or other rough and uneven places upon the castings. If no exhaust fan is used, a glass or metal shade should be placed over the wheel in order to prevent the particles of emery and metal from flying into the face and eyes of the workman, as such particles are extremely rough and sharp, and are difficult to remove from the eyes after getting into them. If such a piece is once imbedded into the eye, a visit to a doctor may be necessary before it can be removed and the eye is liable to be swollen and very painful for several days after the foreign substance has been removed from it. It may even prevent the sufferer from working for several days after the accident.

When small pieces of metal become imbedded in the eye they may often be removed by another workman in the following manner: Seat the injured person in a chair facing the light, and stand back of him, so you can see without obstructing the light. Take a horsehair, or a hair from a hair broom, and after cleaning it well with water and drawing through a clean rag with a little alcohol on it, bend it in the form of a loop. Have the patient hold his eyelids back with both hands, or the lids will involuntarily close. Lay the loop on the eyeball at an angle of 45 degrees, and pass it back and forth over the eyeball until it meets the obstruction. When you have found it, give a sharp, quick pull, and the piece of metal will usually come out easily. It is well to always have on hand a few pieces of horse hair for this purpose, and also a bottle of eye water made up as follows:

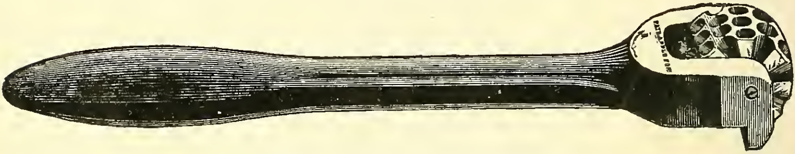

Fig. 20. Emery Wheel Dresser.

Sulphate of zinc	2 grs.
Chloride of sodium	4 grs.
Distilled water	4 ozs.

After removing the foreign substance, two drops of this water should be placed in the eye and the eye closed for a few minutes. If the eye is inflamed use the eye water every hour, two drops at a time, until all inflammation is gone.

Grasp the casting firmly and hold it flatly against the wheel where it is to be ground, using a light pressure so as not to gouge the work or grind too deeply. The work should not be held in one position upon the wheel for any length of time, as in that case it would become very hot, but the work should be moved about, turned over and ground in different places, as required, coming back to the unfinished places after they have had time to cool.

With continuous use the solid emery wheels soon become glazed over upon the grinding surface, causing the wheel to cut slowly. In this case the emery wheel dresser should be used, holding the wheels of the dresser lightly against the face of the wheel until the glaze is removed. This is also the method of truing up the face of the wheel when it becomes uneven, and also of turning up the face of the wheel to reach into special patterns, such as the mouldings of stove castings.

Solid emery wheels are used very little in the polishing room, except upon the rougher castings in iron or brass.

Canvas Wheels.—Next come the roughing-out wheels, which, on castings or any other rough or heavy work not requiring sharp corners, or sharp edges, is usually a canvas wheel, set up with No. 60 emery. Canvas wheels are usually called "roughing-out" wheels; they are very useful in most shops, and indispensable where the work is in the rough, such as castings of iron or brass, and must be worked down. A canvas wheel set up in 60 or 70 emery is usually the first operation in polishing rough castings, after the casting has been trimmed up and the gates removed by the use of a solid emery wheel. While the canvas wheel has a great many uses, it is not adapted for all work. For instance, on parts of machinery, tools, and the like, where sharp edges and square corners are necessary, the leather covered wood wheel is best. As the canvas wheels are soft and pliable, the face is usually not flat; therefore it is hard to keep the corners of the work square when using these wheels; but for a first operation on ordinary work they are unexcelled. They may be made in the shop, if desired, by using heavy canvas or duck, cutting out the discs and gluing or cementing together a sufficient number of the discs to make the wheel of the required thickness. Care should be taken to turn the discs carefully about in gluing up, so that the direction of the threads of the warp and woof of the cloth will run different ways in different sections, so that the wheels will not ravel out easier in certain directions than in others; otherwise the wheel would wear square-sided. All wheels and buffs made up of round sections should have this point carefully looked after, as the life of the wheel and the quality of the work depend on it. If the reader will cut a round piece of muslin and then start to ravel it out, he will see how much easier it is to pull out the threads where they run parallel with each other than it is to do it where they cross each other at the circumference of the disc, and that wheel will wear longest which has this point most carefully observed in its making. After gluing the wheel should be put under heavy pressure until dry, when the hole may be bored to fit the arbor snugly, using a sharp auger, which must be kept at right angles with the sides of the wheel, for if the hole is not straight the wheel will wabble when it is put on the arbor. After boring, the wheel is put on the arbor and its edge is turned up true with a wood-turning tool, or an old file, sharpened so as to use it as a chisel. Then the wheel may be set up with emery, as described for a wood wheel.

It is usually cheaper to buy these wheels, as they are made in the factories in large quantities, and under the most favorable conditions, so that a much better wheel is the result. Canvas wheels made with either glue or cement may be purchased. There is very little difference between them; the cement wheel is more elastic, not so liable to come apart, lasts longer and costs a little more.

For emergencies, a very good home-made wheel may be made by taking several sections of hard-sewed buffs, gluing them together, putting under pressure until dry, turning down with an old file, emery stick, or a piece of solid emery wheel until the face is even, and then setting up with glue and emery.

In using canvas wheels, if on large work, the operator gets a firm hold upon the work and uses considerable pressure, either with the arms, or by putting the stomach against the work to get the pressure. Several of these wheels should always be kept on hand ready to use, as they wear out quickly on heavy work. They should be cleaned off and set up as fast as they are worn out, in order to have plenty of time to dry before being used again.

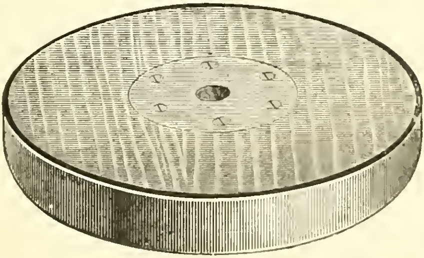

Fig. 21. Wood Wheel.

Wood Wheels.—For particular work, where sharp corners and straight edges must be preserved, a canvas wheel cannot be used to advantage, as they have a tendency to round off corners and sharp edges, on account of their softness. For roughing this particular class of work, a leather-faced wood wheel should be used, set up with 60 emery. Having a firm, smooth surface, it will not gouge out or round off edges as would be done by the more flexible canvas wheel.

Wood wheels are usually made from well-seasoned pine lumber, free from knots or flaws, and one inch thick. The sections are cut out round with a saw, having each section of the same diameter as the others. In making up the wheel, use enough sections to get the desired thickness and crossing the grain of each section in gluing up, using very hot and rather thin glue. The glued sections should then be put under heavy pressure for twenty-four hours, to dry. After this a number of holes should be bored through the wheel, about one-fourth of an inch in diameter, into which are driven wooden pegs large enough to fit snugly, the holes and pins being both well glued with very hot glue before driving.

A hole is then bored in the center, large enough to take the iron mandrel hole, which should have flanges on either side large enough to be firmly imbedded into the wheel, so that their outer surfaces are flush with those of the wheel and firmly secured by screws. These iron collars and mandrel holes may be purchased from any dealer in polishers' supplies by those who prefer to make their own wheels. After the flanges or collars are secured, the wheel is next put on the spindle of the lathe and turned down level and smooth, which may be done with an old file, sharpened for use as a wood-turning tool, and using a piece of board that stands as high as the spindle for a tool rest. Care must be taken not to allow the tool to gouge in too deep, as the wheel may be spoiled. Thin cuts should be taken evenly across the face of the wheel until it appears to be flat and even, when it should be finished smoothly with fine sand paper, wrapping the paper over a file, so that it will present a uniform surface, and applying it to the surface of the wheel while it is still in motion. To find out if the wheel is perfectly true, use a piece of chalk or a soft lead pencil on the tool rest in place of the turning tool, holding it firmly upon the rest so that it will barely touch the face of the wheel. If the wheel is true it will leave an even mark entirely around the wheel; if not true, it will be marked only in places. When the wheel is perfectly flat and true, it is ready to receive the leather covering, which should be of the best oak-tanned sole leather. The wheel should now be sized; this is done by applying thin, hot glue to the face of the wheel until it has been thoroughly and evenly covered; the quickest way to do this is to hold the brush against the face of the wheel and revolve the wheel slowly by pulling on the belt with the hand; as soon as it is well covered, start up the lathe at full speed, when the surplus glue will be thrown off the wheel by the motion. The wheel should be allowed to run until the glue becomes dry; then sand paper should be applied gently, to remove all surplus glue, leaving a smooth, glazed surface upon the face of the wheel, to which the glue applied to hold the leather will adhere firmly. Now have the leather cut the proper width. It should be a little wider than the wheel and a little longer than will go around the wheel. Put the wheel in a vise and apply hot glue for about one-fourth of the way around; apply the squared end of the sole leather and fasten it on the wheel with a shoemaker's awl, a light hammer and wooden shoe pegs. Put a peg in each upper corner of the leather; then

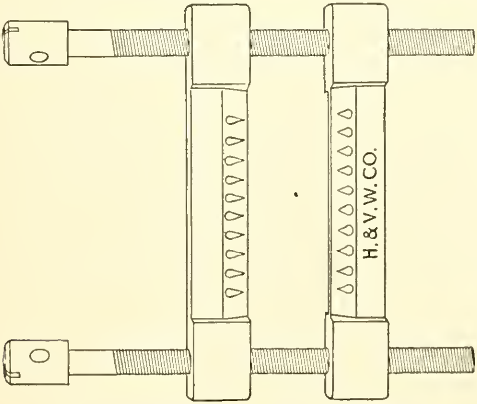

Fig. 22. Wood wheel Cover Clamp.

attach a weight to the lower end of the leather, to keep it under strain. Now tack on the leather as far as the glue has been applied, putting the pegs about two inches apart; turn the wheel in the vise, apply more glue and more pegs, and repeat the operation until the leather is on; have the ends of the leather meet evenly and closely; then more pegs may be applied, until they are not more than one inch apart all round the wheel.

We illustrate elsewhere a wood wheel cover clamp, recently invented by a practical polisher, which is finding favor with the trade. It consists of two iron bars, bearing sharpened steel points on the inner edges and held parallel to each other by hand screws at each end. It is used by gluing the wheel all the way around, separating the bars a little, applying the sole leather clear around the wheel and applying the clamp to the two ends of the leather by means of the inclined pointed teeth of the clamps. Tightening the screws then strains the leather over the circumference of the wheel easily and quickly, when pegging may be proceeded with on the greater part of the circumference. The time gained and the ease of operation make it a favorite tool when once tried.

The wheel should now be dried thoroughly, then turned down a little, both edges and face, sand papered and sized with glue as before. Finally, sand paper off the surplus glue and then set up the wheel, which is done as follows:

Setting Up Wheels.—Place a mandrel in the hole in the wheel, long enough to project on each side and serve as a handle; any piece of pipe or a round piece of hard wood will do; it should fit the hole snugly, so that the wheel will not wabble when you are rolling it in the emery. Then apply hot glue to the surface of the wheel, taking care not to leave any dirt or hairs on the surface of the wheel. Also see that the glue is of the proper thickness—about the thickness of molasses is best; if it is too thick, too much glue will be applied, and if too thin it will not hold the emery well. After the hot glue is evenly and quickly applied to the entire working surface of the wheel, it should be thoroughly rolled in powdered emery of the desired grade several times, using light pressure, until the surface of the wheel is thoroughly and evenly covered. The wheel should then be allowed to dry for eight to ten hours without any artificial heat, when it will be ready for service.

Where much polishing is done, great care is necessary to keep the different grades of emery from getting mixed with each other. Each grade should have its own box, which should be provided with a hinged cover and have the number of the emery plainly marked upon the box. The boxes should be of such shape and size as to permit of the wheels being set up, or coated with emery, without removing the emery from the box. A long, narrow box, quite shallow, is best. The different grades of emery are also carried from wheel to wheel by the glue brush, unless great care is exercised; for instance, a man may set up a wheel with No. 60; the next man may want to set up in 120 or 150; consequently, by using the same brush, he is bound to get some of the coarse emery upon his wheels, thus causing much trouble in the finishing of the work. The only way to entirely avoid this would be by having separate glue pots and brushes for each grade. This would do very well for large shops, but for small plants it is sufficient to use care in setting up wheels. It is a good plan to set up all flour emery and fine emery wheels first, setting up the 120, 90, 70 and 60 wheels in their order, and then the brush should be thoroughly washed out in water. In this way, getting coarse emery mixed with fine emery upon the wheels will be avoided.

One of the most important articles used in the polishing room is glue; if not properly applied it will result in a considerable loss in time and in emery and glue wasted. It is requisite that the polisher have a glue that is perfectly uniform, flexible, and of great adhesive strength. The very best glue that can be procured should always be used for setting up polishing wheels, as inferior glue will not hold the emery and stand the pressure and heat of grinding and polishing, but soon comes off. In preparing the glue for the wheels, add cold water enough to cover it and soak until thoroughly and evenly softened clear through. Flat glue should soak several hours; ground glue should soak from fifteen to twenty minutes in cold water before cooking. When sufficiently softened, heat it gradually in a water bath, or a steam kettle. Never dissolve glue with boiling water, as the hot water scalds the glue and destroys a large portion of its adhesiveness. It should never be heated above the boiling point of water, as the excess of heat will injure it so that it might as well be thrown away at once. This is why glue kettles are all water-jacketed, and the man who tries to hasten matters by lifting the inner kettle out and placing it on the fire is wasting his time and wasting his glue. When it is desired to save time in soaking glue, it should be put to soak early in the day, in a separate pail or jar; this allows the glue pot to be used during the day, while giving the glue plenty of time to become thoroughly softened. When this is done it will be found that the glue has absorbed nearly all the water necessary to dissolve it, and it will be much stronger, will flow easier, and will hold better. The best method of heating glue and having it always ready for use is by means of iron steam-jacketed pots. The glue kettles rest in a separate heater, and the heaters are fitted with upright arms to support the wheels while being glued; this brings the work over the pot and allows the surplus glue to drop back into the pot instead of on the floor. When not in use glue brushes should always be kept in water; never allow them to stand in the pot, or to dry while full of glue. It is worth while to take pains enough to keep the brush soft and in good condition to spread the glue quickly and evenly; the difference between a poorly set-up wheel and one that is properly done will show in your work.

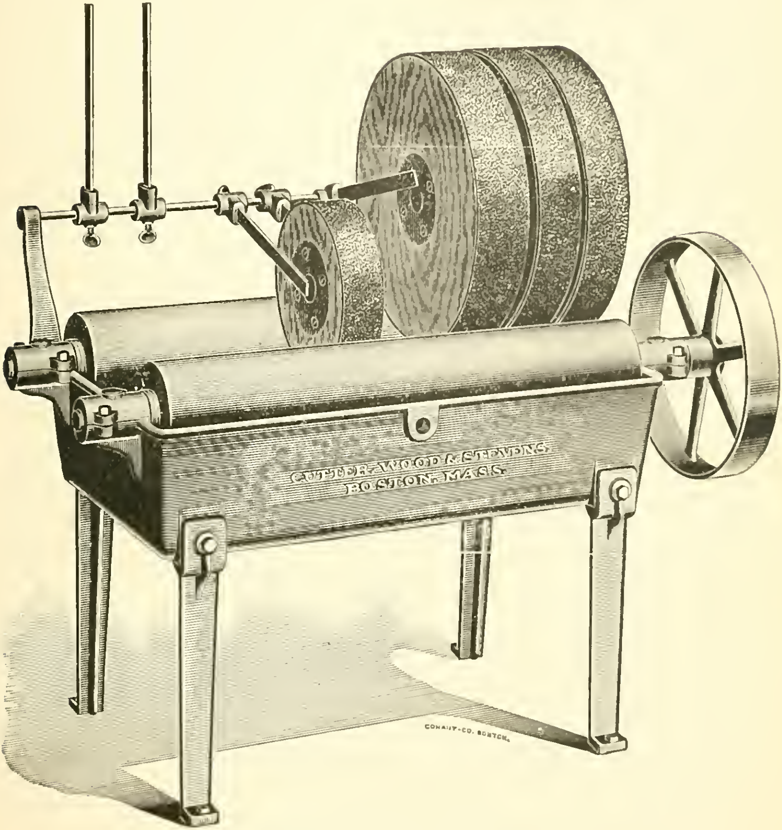
CUTTER, WOOD & STEVENS
BOSTON, MASS.
CONANT-CO. BOSTON.

Fig. 23. Wheel Washer.

Care of the Wheels and Their Use.—Wood wheels are used extensively on any work for which a hard and firm wheel is required, they may be set up in any grade of emery from the coarsest to the finest. When the emery begins to wear off, they are washed, if the establishment has a wheel washer.

By placing the worn wheel in this machine, and letting it run at twenty or thirty revolutions per minute with the water just touching the rollers, all of the glue and emery will be removed without damaging or loosening the leather covering. The wheel should then be taken out, wiped carefully, and put away to dry thoroughly, after which it is again set up with emery. Other patterns have a row of rods near the bottom to prevent small wheels from falling over. The idle roller has two positions for different sized wheels.

As it requires no attention or time to use it, the price of the machine will be saved in a few weeks' labor, and you will have more and better work because of better wheels.

Or the old emery and glue may be removed by means of an emery stick, or buff stick, as it is also called. This stick is made by applying alternate layers of hot glue and forty or sixty emery to a stick of wood until a solid stick of emery is formed. The emery stick is applied with light pressure to the wheel while it is in motion and in this way the old emery and glue are soon removed from the wheel. Care must be taken not to burn the leather coating or facing of the wheel by too hard or steady pressure with the buff stick. When the wheel is clean, it should be set up again with glue and emery, as first described. All the old emery and glue should be removed before setting up wheels again, as, if a patch is left on one side, it is liable to throw the wheel out of balance.

BALANCING WHEELS.—To balance a wheel place in the hole a mandrel that is a snug fit and allow each end of the mandrel to rest on the edge of a level piece of steel that is shaped to have a knife-edge. Care should be taken to see that the knife edges are level and parallel to each other. If the wheel is not true, it will turn until the heavy side is downward; this should be tried several times to make sure, marking the lowest point lightly with chalk, or a lead pencil. Then a small piece of lead is tacked or screwed on the wheel directly opposite the part that points downward.

Now the wheel is again rolled on the knife edges, as it is very easy to get too much or not enough weight on the wheel at the first attempt to balance it, and the operation is repeated until the wheel stops indifferently in any one of several positions, when it will be in balance. All polishing wheels should be kept in balance, as it adds to the life of the wheel and to the lathe. It is impossible to do good work if the wheel is much out of balance and pounding, as it imparts a wavy look to the work, besides unnecessarily fatiguing the polisher. In such a case the emery will be worn away from the wheel on one side while it is still good on the other and thus the polisher will be getting but half the work he should out of an imperfectly balanced or untrue wheel.

GREASE WHEELS.—After cutting down the work on one of the wheels described it is gone over the second time on the "grease wheel." Grease wheels are usually made from wheels that have been worn smooth in polishing and do not cut freely; but it is necessary that the face of the wheel shall present a uniform surface, not having the emery worn off, or chipped up in places. Grease wheels are made only from wheels set up in 120 emery, or finer, and may be made on wood, leather or felt wheels, as desired, by applying grease or oil to the wheel while it is in motion, followed by a little fine emery cake or paste. A convenient way of applying the oil without getting too much of it on is to roll up tightly a piece of cloth, saturate the end with oil and apply it to the wheel as required from time to time. Some polishers use a piece of tripoli polishing cake for making grease wheels instead of the oil, as it usually has sufficient grease in it for the purpose. This, however, is open to the objection that it is easy to get on too much and the grease will then not retain the polishing powder, making the work much slower than if oil and emery alone were used on the wheel.

Dry Fining.—If very fine work is required the polisher goes over the work a third time upon the same wheel, without the use of any oil or grease, and this process is known as dry fining. It consists in going over the work with very light, even pressure on a very smooth wheel of fine grain; as use tends to roughen the surface of the wheel and thereby interfere with obtaining a very high polish, a piece of charcoal is held lightly against the surface of the wheel from time to time, going evenly over the surface, followed by a piece of fine, even-grained hard flint or porphyry, until the surface of the wheel again becomes smooth and glazed, when polishing is resumed. The use of the charcoal and flint stone maintains a surface upon the wheel that will give the very best results. A flint, or finishing stone, as it is called by some polishers, is a little piece of personal property owned by nearly every polisher who is fortunate enough to get hold of one. Lump pumice stone is the proper thing to use in removing the grease from the grease wheel, preparatory to dry fining, or the glaze from the finishing wheel after concluding the operation. It will sharpen immediately any wheel set up with emery that does not cut well. The lump pumice is applied to the wheel with light pressure, a little at a time, until the wheel has been evenly gone over and the dull or glazed spots have all disappeared.

Endless Polishing Belts.—These are made for use on the belt strapping machines, Figs. 16 and 17. They are made of canvas, duck and woven cotton, being had in any width and length, from three-eighths of an inch up to twelve inches wide, from the regular stocks, and wider ones have been sometimes made to order. They are set up with glue and emery in the same way as canvas and leather wheels and used in the same manner. Two flanged pulleys are required to use this belt, the flanges being necessary to prevent the constant side strain from moving the work across the middle of the belt, resulting in throwing it off the pulleys. The driving pulley is generally the larger, as the belts are run pretty loose and the extra surface is needed on that side; the idle pulley is made small for convenience, as people and work are constantly passing near it. The driver is fastened on the spindle of a lathe and the idler put on a swinging standard which is bolted to the floor at a suitable distance, and controlled by a curved ratchet and pawl, operated by a lever, as will be readily understood by a glance at the illustration shown.

It is not necessary to remove all glue and emery from these belts when they become worn. They may be cleaned up with a piece of lump pumice stone while in motion and then removed, glued and set up with emery. When the belt becomes rough from too many coats of emery and glue, so that it begins to chip off, all the old glue should be soaked off and the belt dried and set up anew. It is a good plan to put them upon pulleys while drying. The belt strapping outfit is very desirable in the polishing of certain kinds of brass and iron goods, where ordinary wheels cannot be used to advantage, such as cycle fittings, brass cocks and upon inside surfaces where wheels cannot enter. They are also valuable for tubes, long pieces which would interfere with the workmen at other lathes and for cutlery.

LEATHER WHEELS.—There are many kinds of leather wheels, all having their uses. Some polishers prefer one kind for a certain class of work, some another, but a good polisher, if he does not have just what he wants, will usually get along with what he has, provided that there is a variety to choose from.

WALRUS WHEELS.—As indicated by the name, the walrus wheels are made from the tanned hides of this animal. As they are comparatively scarce and the leather ranges from one-half inch to one and a half inches thick, making it difficult to thoroughly tan, these wheels are naturally high priced, but being almost indestructible they are, in the long run, a cheap wheel. They are used chiefly in polishing cutlery, hardware and tools, where fine work is required. They may be turned up in different shapes, as best suits the work at hand, or they may be grooved to fit rods, balls or screw heads, etc. They may be set up with glue and emery for cutting down, greasing and dry fining, or used without glue and emery, as finishing wheels, crocus or rouge being substituted for the emery. Care should be taken to avoid turning down these wheels, as it would be a waste of valuable material. These wheels are usually sold by the pound, already cut in the size desired, but large cutlery manufacturers and others who use considerable of this leather frequently buy an entire hide and cut their own wheels. In this way, by careful cutting, very little waste is made, as all the small pieces are useful for making polishing bobs for small places and inside work. In buying walrus wheels already cut care should be taken to see that they are of as nearly equal thickness all round the circumference as possible. Of course, it would be impossible to get this kind of wheel of the same thickness all through, owing to the nature of the leather, but care should be taken to avoid getting a wheel very thick on one side and thin on the other. Also avoid, if possible, wheels with deep creases or wrinkles running through them, as they spoil the edge or face of the wheel.

BULL NECK WHEELS.—Bull neck wheels are made from the neck portions of sole leather hides, but, being so much thinner than walrus leather, thick wheels have to be made up in layers, and the leather lacks also in the finishing qualities and durability of the walrus hides. Being much cheaper, however, it is used extensively on bicycle, stove and other iron and steel work.

SHEEPSKIN WHEELS.—Sheepskin wheels have a variety of uses. They are made up of layers similar to a canvas wheel, by gluing or cementing the leather discs together and turning up into the proper shape, after which they are set up with emery. These wheels are of no value to use as finishing wheels without glue and emery, as are walrus and bull neck wheels, on account of their being made up of so many sections or layers, as they will spread and come apart under the pressure and heat of the polishing operation. For a soft and durable cutting down or greasing wheel, however, they have a steady, though somewhat limited sale. They are made in two qualities, hard and soft.

COMPRESSED LEATHER WHEELS.—Compressed leather polishing wheels are made by forming a rim or felloe for the wheel, of sole leather pieces cut by a die to a previously determined shape, and holding them in place by compression between two steel discs which form the hub or center of the wheel. They are made hard and soft and have had considerable use on account of the fact that they can be made any width, can be turned up in any shape and can be refilled when the sections are worn out. It is a very satisfactory wheel where it suits the work, but can never replace walrus on fine work.

Compressed wheels are also made up with canvas instead of leather sections. They have the advantage of not splitting or coming apart, as canvas wheels sometimes do, but are more costly and have not found general favor on that account.

FELT WHEELS.—Of all the materials used in the different kinds of polishing wheels felt is in the most general use and makes the very best general purpose wheel. It can be used for roughing, grinding, polishing and finishing, and when the glue and emery are removed and a little crocus, rouge or polishing compound is applied it brings out the highest polish and best color on nickel plated articles, especially of iron or steel. These wheels are very desirable in buffing stove work, where the background is a dead white and it is desired to keep it so. If we use the ordinary buff, the background, or chased work, is readily filled up with the rouge, or buffing compound, and dirt from the wheel, so that it must be washed out with lye and a stiff brush. If we use the felt wheel and a little rouge, or some of the compounds known as white rouge, or white coloring compounds, being white, it does not show if any should adhere to the work. If a little care is taken the work may be buffed on the felt wheel without getting any dirt in the white background. In buffing nickel in this way, after the pieces have been gone over thoroughly, a little whiting or Vienna lime may be applied to the work and a little also to the wheel, and the work gone over lightly again. This removes all grease and finger marks and gives a white finish which is almost impossible to obtain in the ordinary way, with the regulation cotton buff. This mode of finishing is not necessary for brass goods or for the cheaper class of work and is not recommended for them, as it takes more time than finishing with the cotton buff.

In using felt, walrus or leather wheels for any purpose they should be run with the nap. Many persons using polishing wheels do not know that these wheels have a nap, but they have, and it is very important that they should be run with the nap and not against it, in order to secure the best results in work and the life or durability of the wheel. Before putting on a felt wheel, rub the finger along the face and side of the wheel, first one way and then the other. You will discover that it feels rough one way and smooth the other. The wheel should be run so that it has a tendency to smooth the felt instead of roughing it. When once ascertained which way it should be run, it should be marked with an arrowhead pointing the way it should go, this can be done with a pencil or small paint brush, on each side of the wheel. Then the wheel should always be run in that way.

In using felt wheels for polishing care must be taken not to use too heavy or too steady pressure, especially on large and heavy work where considerable pressure is necessary, as under such circumstances the wheel is liable to catch fire under the surface coating of glue and emery and smoulder away for some time, eating a long hole in the wheel, so that it looks as if it were worm-eaten, when you come to turn off the emery preparatory to setting up the wheel again. This firing may not be suspected by a careless polisher until the wheel gets out of balance and begins to pound, or it may be discovered by eating along the surface until the coating of glue and emery breaks through. Many wheels are fired in this way when turning off the old coating of glue and emery with the buff stick preparatory to setting up, if the work is hastened by using too much pressure. Such a wheel must be turned down to the extent that the fire has eaten it and it will readily be seen that the loss is considerable.

There are several grades of felt wheels, both white and gray, and it is cheapest in the long run to buy the best grade of white felt, known to the trade as Spanish felt. This costs more than the other grades, but is undoubtedly the cheapest and best in the end, as it lasts longer and gives far better results than the cheaper grades; in fact, to use the cheap gray felts is throwing money away, as they do not hold the emery and glue well, are too soft and spongy for good work and there is a great waste of felt in turning down, which is not the case with the best white felt.

In setting up felt wheels it should be done in the manner described for leather and leather-faced wood wheels. First get the wheel turned down to the proper shape. It should run smoothly and evenly, if properly balanced. A felt wheel may not pound or chatter and yet not be running true. To find out if it is running true, take a piece of chalk or a soft pencil, use a piece of wood standing on the floor for a rest, and hold the chalk in one position firmly on the rest, very close to the wheel, so as to barely touch it. Then remove the chalk, stop the lathe and examine the wheel; if it be untrue it will have the chalk marks only on a part of its circumference, whereas, if it be true they should be found all around it. To remedy this, loosen up the nut and turn the wheel half-way around on the spindle, tighten the nut and try again. If it is still out it must be turned down until right, using a chisel made of an old file, or a buff stick, and finishing with sand paper on a flat stick. Then the wheel is coated with hot glue while on the spindle, started up immediately and allowed to run until the glue is dry, when it should be partly turned off and smoothed down with sand paper on a stick. Now remove the wheel, apply the hot glue thinly, evenly and quickly; roll the wheel in the proper number of emery, using a mandrel through the hole for a handle. Allow the wheels to dry slowly and naturally. Wheels are usually set up at the close of the day's work and allowed to dry over night. In case of emergency, the wheels may be dried on steam pipes or in ovens, but, if dried too quickly, the glue cracks and chips off, thus spoiling the wheel for use until again set up.

Felt wheels set up in 120 or 150 emery are often used for roughing; then, by the adding of a little grease or tripoli to the same wheel, they are used again on the same work, as grease wheels. Then, by using charcoal on the wheel and a flint stone (which every polisher should possess) to apply to the face of the wheel while using the charcoal, the same wheel may be used again for the last, or finishing, operation on the work. By the free use of charcoal and a smooth flint stone to a good 150 or flour emery wheel the best finishing wheels are made for iron or steel. When the surface of the glue and emery is chipped or worn off it should never be used as a finishing wheel; one that is perfect all round is best. Then, by applying lump pumice stone, the glaze and grease may all be removed, and you have a sharp wheel again for polishing or cutting.

METHODS OF WORK.—In the roughing out, or first operations in polishing, the work may be polished all one way, or crossed by each successive operation, according to the class of work, using the most rapid means of getting it to any kind of an even and smooth surface; but in the finishing operations, from the grease wheel to the finishing wheel, the polishing should be all one way, which will permit the work to take on a high polish sooner than if each operation crossed the previous one. The work should be held on the wheel at about the middle of its lower front quarter; any other position would be wrong and dangerous, as in holding the work too high or too low on a wheel of any kind it is liable to catch on the wheel and be knocked or jerked from the hands of the operator; this is especially true in the use of buffs. If the work be plain, no serious damage may be done by this ignorance or carelessness, as the case may be; but if the work happens to be a piece of chandelier, a scroll, or a bracket, or any other complicated piece, the result may be serious, both to the polisher and to the work.

To grind or polish a surface requiring straight edges and sharp corners, it is necessary to have a wheel with a smooth, flat face, running perfectly true. No bouncing or shaking of the wheel can be permitted.

In polishing, the work should always be held firmly in the hands, using gentle and uniform pressure in holding it up to the wheel. When applying the work or removing it from the wheel, do so abruptly and firmly; that is, do not remove it gradually, as it is apt to let the work be touched on a sharp edge or corner, which is the thing to be avoided. Long practice and an accurate eye are the essential things to keep sharp corners and straight edges in polishing.

The length of time for one operation, or the time to use a wheel, is usually until the coarser marks left by the previous wheel are removed. Thus, when the work has been run over by a 60 or an 80 emery wheel the next operation is usually with a 120 wheel until all the 60 or 80 marks disappear and only 120 marks remain; then it is ready for the 150 emery, or grease wheel, as the case may be.

If a man is working on small or fine work, he usually sits down to his work, as it may be handled more comfortably and more accurately while sitting. If the work is large or heavy, he can do better work and more of it while standing.

In large shops where the same class of work is handled continually, say a bicycle shop, for instance, one man works altogether on sprockets; another on handle bars; a third does nothing but cranks, and so on. Each man has his own special wheels in different sizes and shapes to suit his particular work. He takes on his day's work in the morning, usually a certain number of pieces, and puts them through one operation after another until the whole are finished; that is, he puts the entire number through one operation before changing wheels and proceeding to the next stage. In this way a good polisher is usually able to double his output in three or four months from beginning on that particular piece of work, as by daily practice he comes to know just where and how he can make time on that particular piece.

If he has plenty of wheels to carry him through the day's work he usually sets up his wheels in the afternoon, after finishing his day's polishing; if he has but few wheels, it is wise, and often necessary, to set them up as fast as they have become worn off, so as to be ready for the next operation.

It is the most common practice for each man to keep his own set of wheels and look after them; also to carry his work through from start to finish. Where one man does one operation and passes his work along to the next there is usually too much criticism and fault-finding with each other's work, and this may be carried to a point where it is subversive of all good feeling between the workmen in the shop, and is, of course, injurious to discipline and hampers the output of the work. Every good polisher likes to have his own set of wheels, and when he gets them set up and broken in to suit him he guards them closely; this is necessary in order to keep his wheels for his own use, especially in large shops where many a workman is inclined to borrow his neighbor's wheel when he is not looking rather than set up his own. Polishers usually aim to set up their wheels for the next day's work in the evening, just before quitting time, as that gives the wheels all night in which to dry; this is always the case when the men are employed on piece work. In this case a good many wheels are required by each workman, and the number and kind will vary according to the class of work upon which he is employed; but he should be provided with a sufficient quantity of suitable wheels, so that it will not be necessary for him to break in upon his day's work to set up wheels for that day.

Tubing or round iron rods are always polished cross-wise —never lengthwise; if the piece be too long and heavy to handle easily one end may be put in a sling, made by attaching a rope to the ceiling and having the loop so that it will hold the work at the same height at which the workman holds it in polishing, so that it will bear on the full width of the face of the wheel, which it might not do if one end were higher than the other. By having the rope close enough to the wheel nearly all the weight may be supported by the rope for half the length of the piece, when it should be turned around and work begun at the other end, the two operations meeting in the middle. In this way great freedom in handling long pieces may be obtained and the speed correspondingly increased.

Brass chains, such as plumbers' chain, dog chain, key ring chains, etc., very often require plating and polishing; these chains often cause accidents to the inexperienced workmen. The best and safest way to polish a piece of chain is to take a piece of broom handle, or other round stick, about twelve or eighteen inches long, drive a nail in one end, letting the head protrude half an inch; hook one end of the chain over the nail; then wind tightly, holding one end of the chain in the hand and polishing the part held on the stick as you would a piece of tubing; when one side is polished, unwind, turn the chain over and repeat; when both sides have been polished repeat the operation with another portion of the chain until it is all done.

Musical instruments, especially cornets, are quite difficult to polish. As the metal is often quite thin, care must be taken to avoid cutting through or denting the instrument. For this reason large wheels are seldom used, as there is great danger of the instruments catching on the large buffs, which must be avoided, as an instrument is very easily ruined in this way. For polishing before plating, small, hard buffs and tripoli should be used on the plain portions and small leather bobs, used on the end of the taper, should be used on the difficult places, where the buff cannot reach; where neither buffs or leather bobs can be used, a strip of cotton to which tripoli and oil have been applied may be used, running it through the space to be polished and pulling it back and forth quickly by holding ends of the cotton in each hand while the instrument is held between the knees, or by an assistant.

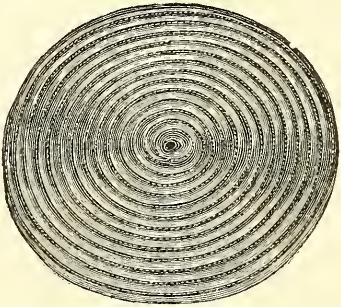

Fig. 24. Pieced or Sewed Buff.

Buffs and Buffing Compositions.—Buffs differ from the numerous wheels we have described in two ways: they are almost invariably of loose sections of cloth, so that they will spread out on the work to be polished in a degree varying with the stiffness of the sections, the speed of the buff and the pressure exerted by the operator; they are used without glue and emery—its place being taken by various kinds of polishing compositions which are held against the buffing wheels from time to time to set them up during the progress of the work. They are used for cutting down and polishing work after it has been fined with emery, or for work on which emery cutting is not needed, such as sheet metal, machine parts that have been finished all over before coming to the polishing room, etc. They are of many kinds and qualities, from the firm, hard buff, cut from heavy, hard-twisted, closely woven, unbleached muslin to the softest, loosely woven canton flannel, used for coloring gold work. They are made from muslin bought from the mills especially for the purpose, and they are made from the scraps left from cutting shoe linings, odds and ends from shirt factories, overall factories, the spoilage from cotton mills, and the pieces left from cutting buffs out of whole cloth. A pieced buff is always sewed, either spirally or in concentric circles with whole pieces on the two outer sides of the section and the center of the section made up of a number of layers of pieces cut in the shape of segments of a circle and crossing each other in such a way as to be reasonably uniform in thickness; the stitching ravels out in use and permits the layers of cloth to spread until the next row of stitching is encountered. In this way the stitching serves two purposes; it holds the various pieces of which the buff is made up and it stiffens the buff so that it will stand up to its work without being run at an excessive speed.

Many platers have erroneous notions about buffs; some of them invariably buy the lowest-priced buffs in the market, with a mistaken idea that they are economizing thereby; if approached in regard to the higher-priced article, they will tell you how many sections they are using per month and declare that they could not think of paying the higher price, as the profits in plating are so small that it is necessary to economize in every direction, etc. Now the facts are that a buff will do work exactly in accordance with the amount of long, hard twisted fibre in it. When a dealer in cloth is approached with an offer on muslin he pulls out a small magnifying glass, called a linen tester, puts it on the cloth, counts the number of threads per inch in the cloth, looks at the size of the individual threads and their distance from each other, estimates the amount of starch and gum with which the cloth is loaded, and finally ravels a few threads, untwists them and looks at the length and strength of the cotton fibre in the threads of which the cloth is composed. If the piece is heavily loaded, he makes a mental deduction from the price per pound asked for the muslin; if the thread has a large percentage of short fibres in it, he makes another, because he knows that the strength is not there and the cloth will not wear well. The plater, on the other hand, with few exceptions, looks merely at the price per section and the salesman who offers the lowest price per section, by an eighth or quarter of a cent, gets his order. Of course the goods are made up so that low-priced sections can be offered to people who insist upon buying them, and such buffs are invariably the most costly. The plating supply houses cannot be blamed for doing this; they have been forced into supplying low-priced buffs for bargain hunters, and cotton is as staple a commodity as iron and the price is subject to less fluctuation, so that a reduction in price is always accompanied by a similar reduction in quality. Most of the supply houses have high class buffs at a corresponding price, and they prefer to sell these goods, knowing that they will give better satisfaction to the user; the labor cost in making them is about the same on all buffs and the higher price simply buys more and stronger cotton, instead of gum, starch and short fibre. The experienced buyers have proved this many times. Perhaps it may be well to give the results of a trial which took place within the writer's knowledge: the house in question (a large stove concern) was accustomed to buy about 10,000 sections per month of a fourteen cent buff when it employed a bookkeeper who had recently been in a dry-goods concern which had a large wholesale trade in muslin. He found fault with the buffs, and the salesman to whom he complained promptly produced a twenty-four cent buff of the same size, and after some argument got a trial order for them. In the test which followed the twenty-four cent buffs wore as long as three buffs of the fourteen cent sections which they had been using. In other words, twenty-four cents' worth of first-class muslin did as much work as forty-two cents' worth of poor muslin, and the saving on the firm's monthly bills was very considerable. The plater who will learn to distinguish between good and bad buffs will be able to effect a considerable economy in the matter of buffs alone if his firm does any considerable amount of work, as they are constantly being used up, and mistaken notions of economy are liable to make a steady leak in the way of useless expenditure.

The size of buffs is another question that will bear study. A buff cuts fastest when it is being run at a speed that will make it stand up stiffly; in other words, the buff is held to its work best when the centrifugal force of the rotation holds the periphery of the buff farthest from the center. The larger the buff the greater the peripheral speed will be with a given number of revolutions of the lathe spindle. As the buff wears down it becomes smaller and the number of inches per minute passing over the work is correspondingly reduced, until it reaches a size where the fastest speed to which the lathe spindle can be set fails to give a sufficient number of inches of travel to the outside of the buff to make it cut properly. When this point is reached it should be thrown away and a new one substituted. Cutting down buffs should run at from 9,000 to 15,000 feet peripheral speed per minute; perhaps 12,000 feet is a fair average. Coloring buffs should run from 5,000 to 8,000 feet per minute. The amount of work turned out is less with a small buff than with a large one in any given time; if the shop is crowded with work and the polishing room is behind the substitution of large wheels and buffs will frequently speed up the work so as to make the addition of more lathes and men unnecessary. Where there is a lack of room for additional machinery, or polishers are difficult to obtain, this is often the only way out of the difficulty. Then, too, where the polishers are paid by the day and the proprietor is always complaining of the number of new wheels and buffs furnished the polishing room, the men are apt to continue to use wheels long after they should be thrown away. It is a common sight in such places to see the men holding work against a three-inch buff or wheel, laughing and talking and spending an hour over work that should and would be done in twenty minutes with a fourteen-inch buff. In such cases the proprietor is losing every day, in the wages of the men, more than enough to provide an entire set of new buffs for the shop.

This question of size may be carried to extremes, however, as it is possible to get buffs so large that they cannot be cut economically from the muslin, on account of the increased waste from the spaces between the large circles on such large buffs, and the maker charges more per pound for such increased sizes. There is a fad in Milwaukee for eighteen-inch buffs; this is not an economical size; other places like sixteen-inch buffs, believing that more work can be done with them at a lower speed of the spindle than with smaller sizes; nothing is gained, we believe, in such extremes; it is an even thing as to power consumed in revolving a large buff at a lower speed or a smaller buff at a higher speed. The wear on the spindle boxes is easily repaired by rebabbiting, and the power expended in the work is the same, while the lower price per pound of the fourteen-inch buff makes it the most economical size to buy in the majority of cases. If the lathe countershaft has cone pulleys with a sufficient number of changes of speed, buffs can be worn down quite small with economy, and this point should always be looked to in fitting up a shop, or in adding lathes to an existing polishing room. There is generally enough work that demands small buffs in any jobbing shop to make it desirable to have a fast spindle on which they can be economically run; meantime the large stove shop, or other special plant, must decide for itself whether it is cheaper to throw away small buffs or to stand an increased outlay in wages and power for using them up. It is impossible to economize beyond a certain point in such cases, because decreased expenditure in one direction means a slowing down of the output and increased expenditure in others.

Sewed Buffs.—The muslin buffs made up in sections and sewed in a continuous spiral are used mostly for cutting down or buffing heavy work in iron or brass. As many sections may be used as required to get the desired thickness. Either emery paste or tripoli is used, according to the class of work being done. After the wheel is put on the spindle, if it does not run evenly, projects in places and has ragged edges, as such wheels usually do, it should be started up and combed out or evened up with the point of an old file.

Whole Buffs.—These are made of muslin of either bleached or unbleached cloth, and have the sections sewed or stapled only around the arbor hole. They are used for many different kinds of work which require less pressure than can be given by the sewed buffs, such as buffing brass copper or bronze goods, and also for buffing plated goods of all kinds, except gold and silver. In buffing copper or its alloys, to remove grinding and polishing marks and scratches, tripoli in the form of cakes or bars is generally used, applying a little to the wheel every few minutes while in use by holding the cake lightly against the wheel for a second or two and then withdrawing it and proceeding with the work. In case the work is quite rough, or has deep scratches or pinholes, the cutting of the buffs may be facilitated by dipping the tripoli into kerosene before applying it to the buff. In order to avoid covering the buff with grease and thereby hindering the progress of the work and wasting material, the polisher should understand that all the various polishing cakes he will use consist of varying sizes of powders, which have been put into kettles and stirred up with mixtures of soap, wax, tallow and oil and then run into moulds and allowed to cool. The soap, tallow, wax and oil are so proportioned to each other and to the amount of polishing powder that they will hold the powder on the buff and furnish a lubricant for it while it is cutting the metal. Now if the polisher attempts to hurry his work by using lots of polishing cake, or if he is careless in applying it and holds the cake against the wheel so long that he gets too much on, the heat generated by the buff rubbing the metal will melt the composition and the powder will fly off without doing any work, while the grease will remain and saturate the cloth of which the buff is composed. In a very bad case polishing will be next to impossible, and the more cake he uses the worse off he will be. Of course he will blame the manufacturer of the polishing composition which he may happen to be using when the fault is entirely his own. If the work comes away from the wheel looking dirty and greasy, instead of clean and bright, you are using too much composition and not doing the work with the speed that you

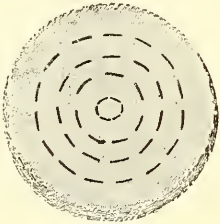

Fig. 25. Medium Buff.

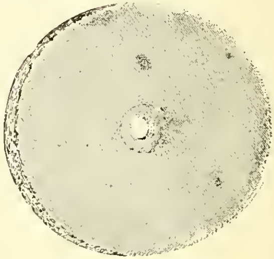

Fig. 26. Soft Buff.

should. You should understand thoroughly that you cannot charge a buff heavily with composition without getting into immediate trouble. A little composition applied for a second or two lightly against the cutting face of the buff and repeated when the buff slows up in cutting, leaving the work clean and bright, is the proper way to use it, and any other way will only waste time and composition. When a buff has been thus greased it should be cleaned by holding a stick or an old file against it until the grease has all been taken off; then by applying the composition lightly and quickly the buff may be worked back into good condition again in the course of ten or fifteen minutes.

When the work is sufficiently cut down to suit it may be finished for plating or lacquering, as the case may be, by a similar wheel, except that crocus, rouge, or white buffing or coloring compound should be used in the place of tripoli. The same wheels should not be used, as a general thing, for cutting down and finishing; there should be a separate wheel for each operation in order to obtain the best results; still, in case of emergencies, the tripoli wheel may be used for finishing by first thoroughly cleaning it with an old file or other suitable tool.

The same class of wheels and material is used for finishing plated goods in nickel, brass, bronze and copper; less pressure is used in order to prevent cutting through the plate; also less rouge or buffing compound, for the same reason. In buffing plated goods during the last operation the work should be buffed one way as much as possible.

COTTON FLANNEL WHEELS.—These are used chiefly in polishing sterling silver and silver plate. White buffing compound, or some similar form of "White Rouge," as these white polishing compounds are called in the trade, is used quite extensively on silver, as it gets a very good polish and has the advantage over rouge in that it does not fill up all cracks and crevices in the work as rouge does; still, rouge has the preference in many shops, polishers sometimes being prejudiced against anything but the old and well-known methods that they know will give results.

ROUGE.—Rouge is used in two forms, hard, or stick rouge, and soft or powdered. The hard rouge is usually used first, to remove any fine scratches and to put on the first polish, but for the final finish, or color, soft rouge, mixed to a thin paste with alcohol and water (half and half) is used. It is applied to the work and a little to the wheel with the finger; it is not necessary to use much of the paste. If the dirt or rouge sticks to the work in places rub on a little of the wet paste to the spot and buff again. The buff may now be cleaned out with the point of a file and the work gone over again lightly, which should give a clean surface and a beautiful polish. A little coal oil is used by some instead of alcohol and water; also ammonia and water can be used as a substitute; alcohol and water in equal parts is in most general use however, and gives good results.

Rouge is put up in two or three forms and in many grades. It is one of the oxides of iron, like crocus, and the finer qualities have extensive use as polishing agents in all the finer varieties of metal working. Gold rouge is the finest and most carefully floated powder, as the gold is very soft and easily scratched if any coarse powder be allowed to become mixed with the paste or stick intended for that metal. It is used in sticks and in the powdered form, mixed with alcohol and water. Silver rouge is coarser, not having been floated as long as the gold rouge. They are practically the only polishing agent used in finishing gold and silver after plating, partly on account of the color being most suitable and also because of the readiness with which they may be graded in the manufacture, so as to avoid scratches. Nickel rouge is the same substance, but not of such fine quality; this is used in the hard form and usually has a little more lubricant in the composition of the stick, as nickel is so hard that it requires more polishing than silver or silver plate.

Gold and gold plate are finished in the same way as silver. Both gold and silver plate should be burnished in order to give the best results, as the pressure of the burnisher tends to harden and perfect any spongy or porous deposits of the metal, and so leaves the whole coating harder and enables soft metals, like the richer alloys of gold, or pure silver, to resist wear better. However, they may be and often are finished on the buff without burnishing; but for good work it is necessary that the plate be first burnished before buffing.

In polishing watch cases and jewelry many different kinds of wheels and brushes are used, the most common being small bristle wheels, which are used for polishing the gold article with tripoli to remove scratches and also with hard rouge for finishing. Many small buffs are also used which are made of cotton flannel, felt, raw hide, chamois skin, etc. The latter are used especially on watch cases, both for tripoli and rouge buffing.

All gold and silver work, after being finished on the buffing wheel, is usually washed out with hot soap-suds, to which a little ammonia has been added, then rinsed in hot water and dried in boxwood saw-dust, or with clean, soft rags, as the case may be. Boxwood saw-dust is used because it will not discolor articles with which it comes in contact, as many of the other kinds of saw-dust will do with metals that are easily affected, such as the cheaper alloys of gold and sterling or pure silver and many copper, brass and nickel alloys. Hence it is always better to pay the price for boxwood dust rather than risk spoiling the work and having to do it all over again. Rags for the finishing may be old bed sheets, or any thoroughly bleached and partly worn muslin, which must be clean and dry.

In polishing steel or iron emery paste is used. This is fine emery made into a cake by the use of oil, tallow and wax. It is applied to the wheel in small quantities, either to emery grease wheels or to the cutting down buff for iron work, and greatly facilitates the labor.

Tripoli.—Tripoli is usually mixed with tallow and beeswax, all being melted and mixed well together and run into moulds of a handy size and shape. The tallow furnishes the necessary lubricant, while the beeswax gives the composition its adhesive qualities. It also assists in the cutting and polishing operation to a great extent; therefore beeswax in excessive quantities in the mixture makes a very rapid cutting composition, but if too much wax is used, it is liable to adhere to the work and is hard to remove, while an excess of tallow or grease will retard the polishing or buffing operation and cause the work to become greasy or dirty.

Crocus.—Crocus is usually mixed with tallow and oil, just sufficient being used to make it into cakes and furnish sufficient lubricant. Crocus is in general use for finishing steel goods, especially where a high finish is required, such as fine cutlery, tools and surgical instruments. It is also very useful in finishing brass or plated goods, especially nickel. In buffing nickel that is slightly burned or very heavily plated, crocus will be found to give excellent results, as it has sufficient cutting power combined with its polishing or finishing qualities to give quick and good results in the hands of the skilled workman.

White Buffing Compounds.—These are put up under various names, and differing degrees of fineness of the powders and varying composition of the lubricant, so as to adapt them to the various classes of metals. They are sold in cakes and have extensive use in buffing brass, nickel and silver plated work. They give a whiter finish than rouge, cost about the same and have extensive uses where the white color is an object, especially where there is engraving or chasing that is liable to be filled up by the use of rouge. Rouge is not desirable in such cases, as it readily fills up the background and must be washed out with hot lye, soap-suds and ammonia. In doing this the brushes are liable to scratch a fine piece of work and where it is to be lacquered any rouge left on the article will show up badly and is liable to be spread by the lacquer brush and discolor the work. White buffing compound does not fill up the background nearly so much as rouge, and any portions that may be accidentally left on the work are not nearly so conspicuous as rouge and are more easily removed.

Vienna Lime.—This is sometimes used in buffing nickel and silver; to be of any value, however, it must be used while slacking, and it being almost impossible to keep it on hand in any quantity without its slacking in the air, it has not come into general use. Recently, however, manufacturers have overcome this difficulty by pressing it into bars which are dipped into paraffin wax and then wrapped in paraffin paper, thus making it airtight until used. It is being rather extensively employed in watch factories in this form and is said to be meeting with considerable favor for polishing steel work. It disintegrates with slight pressure and slacks in the air while doing so, thus giving a chemically clean surface on the metal.

Sand Buffing.—Britannia metal and other soft metals are not polished like those which we have described, as such treatment would roughen, melt, or pull them out of shape. They are polished with small leather wheels and bobs, made from walrus, bull-neck or sheep skin, according to whether a hard or soft wheel is wanted for the particular class of work in hand. A box or trough is placed under the wheel large enough to catch the flying powder, or "sand," which is finely powdered pumice stone, mixed with a very little oil, so that it will not be sent flying all over the room, but not enough to keep it from running freely from the fingers of the operator as he holds it above the work. Only enough oil should be used to keep down the dust—not enough to make it sticky or lumpy in the fingers. The polisher holds his work to the wheel with one hand, letting it barely touch the wheel, which should be perfectly balanced and true, while with the other he takes a handful of the pumice and allows it to run on the work as it is being polished. Men used to this class of work soon become very expert at it and are able to keep the pumice continually on the work at the right place without interfering in the least with the polishing. Care must be taken in polishing these soft metals not to use too much pressure and not to polish too long in one place, as holes are liable to be made, or the work melted or polished out of shape. The idea is to keep the work turning and moving continually, with a quick, gentle movement. After the work is thus polished, it is usually washed out in soap and ammonia water, to remove the grease and pumice. It is then ready for the plater, provided it is to be silver plated and burnished, but if it is to be silver plated and buffed, as some cheap work is done, or to be coppered for nickeling, or otherwise, the britannia should be gone over again after being washed from sand buffing. The second polishing is accomplished with the same kind of wheels, using crocus or rouge instead of pumice and going over the work lightly.

Although ordinary buffs and tripoli are sometimes used in polishing britannia, it should not be done, as it spoils engraving and chasing and drags the metal instead of polishing it. Then, too, in using large buffs at a high rate of speed the work is easily melted or burned.

All lead articles and those made from its alloys should be polished by sand buffing, as it is impossible to get a polish and retain the shape of the article by using ordinary buffs.

Sand buffing is a dirty job at the best, so precautions should be taken to have it as clean as possible. If much of it is to be done, a good way is to make a box large enough to contain the wheel and give room to handle the work, letting the spindle of the lathe come through the side of the box, and having the front open towards the polisher. The open side of the box may be curtained, to keep the dust from flying about the room, but a place must be left for the polisher to see his work. Then a large apron should be made from a sheep skin or other suitable material; have the bottom edge straight and as wide as the opening in the box; now tack the bottom of the apron to the inside of the opening in the box and have a strap at the top to go around the neck of the polisher when at work. In this way any sand and dirt that is thrown outside of the box when polishing falls upon the apron and may be returned to the box instead of going on the floor or on other work.

ZINC.—Zinc may be polished in the same manner as brass, with muslin buffs and tripoli, first using the emery wheel if necessary, and finishing with white buffing compound, crocus or rouge.

SCRATCH BRUSHES.—Heavy steel wire scratch brushes are very useful in cleaning and removing sand and scale from castings preparatory to plating them, such as stove work and other castings where the scale cannot be entirely removed by pickling. They are of two kinds, packed and swing; the packed brush has its wires fastened evenly about the surface of the hub, while in the swing brush they are twisted in knots and these knots are hung on a rod in the hub, so that they will be at liberty to turn on the rod if the work is held too close to the wheel.

A swing brush should always be driven fast enough to make the wires stick out straight, striking the work with their ends, instead of dragging over it as is frequently done, especially where the work is held too close to the wheel, so that the wires do not get a chance to cut properly. After being run for a time the wires will be found to be bent at their ends in the direction the wheel has been running; the brush should then be taken off the spindle and put back with the other side of the hub next to the collar on the spindle, so that the ends of the wire will again strike the surface of the work, instead of dragging over it. The difference in cutting will be noticed at once. A brush that is run too fast will crystallize the steel wires and they will soon break off; too heavy pressure of the work will also do this, making it necessary to stop and refill the hub with new wires, which are bought ready for insertion.

The packed brush is subject to the same peculiarities, but being more evenly distributed, the wires are stiffer and will run longer under proper usage, although they are more easily broken by careless workmen and the hubs are harder to fill. A swing brush will reach into uneven work better than a packed brush and it is generally used on such work, while the packed brush will cut faster and so does more work in a given time on surfaces for which it is suited. There has been a tendency lately to reduce the size of wire in these brushes and to make the attachment to the hub as flexible as possible, thus prolonging the endurance of the brush by adding to its elasticity.

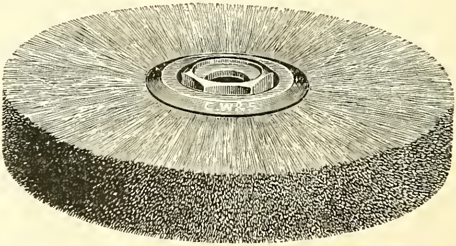
Fig. 27. Scratch Brush for Castings.

This has been made possible by the tendency of foundry practice in producing softer castings. The extent to which this has gone was shown in a curious way recently by an investigation undertaken by a large manufacturer of lathes. He sold a number of lathes to England, making what he considered a conservative statement of their capacities, based on their daily performance in this country. The English purchaser complained that they would not do anywhere near the amount of work that was claimed by the manufacturer and he sent over a man to teach the English machinists how to run them. After extensive investigation, this man reported that the trouble lay in the fact that the Englishmen were using harder castings, such as were common in America twenty years ago, and that the lathes would not do the work that was expected of them in America, unless they were run upon castings that were equally soft. He also reported that they would have to strengthen their tools materially if they were to do as much work on the hard castings of Europe as they were expected to do on American castings as they are made today. This led to extended investigations in which the iron founder came in for a very large and unexpected share of the credit that had heretofore been given to the manufacturers of American machine tools. The plater will readily see the application of this to his business, especially if he has ever had to handle and polish hard and uneven castings.

RATTLING OR TUMBLING BARRELS.—Small objects which are not required to have square edges are best cleaned by rolling, or tumbling, as it is called in foundries. Large quantities of work are thus easily and cheaply cleaned without much manual labor, which is the expensive item in polishing. If rough castings are being worked, the sand, scale, etc., adhering to them is allowed to remain in the barrel, and if the pieces are large or few in number, the dirt from previous rollings, small scrap iron, etc., are added to them so as to about half fill the barrel. It is then tightly closed and set in motion, when the sand, scale and other matter acts as a polishing powder, cleaning the castings, while the small scrap forces the sand into hollows and crevices which it might not otherwise reach.

It may not be generally known that the popular toys called "jackstones" had their origin in the foundry and are still used in large quantities by foundrymen in their tumbling barrels for cleaning up small irregular castings such as locks, keys, toys and similar small articles.

The old practice was to have two barrels, one solid, to retain the dust and sand until it had done its work, and the other perforated with numerous small holes, to clean and brighten the work after it had been rolled in the first barrel, and this practice is still followed today in many foundries. When the plater took up the device he introduced many modifications of it adapting it to stampings in brass and many other metals. For instance the manufacturing jewelers use a small barrel which is perforated and runs in a tank of soap suds. The work, black from the fire, is run in this barrel with tripoli and water until the oxide is loosened, when it is transferred to the soap suds and run slowly. The motion and the soap polish the work to an extent that is surprising. A few gross of rings run in this way will come out bright, both inside and out, and all dirt, metal, etc., will be found in the suds at the bottom of the tank.

It is a principle in burnishing that you cannot get the burnished work brighter than the burnisher, so that a little consideration will show that bright work is only obtained by long-continued tumbling, thus giving time for all the pieces to gradually become smooth, and the bright finish comes rather quickly after all the pieces in the barrel have become smooth. It is therefore necessary to handle the work in batches and not to add more after the batch has been some time in the barrel, or the work will not finish evenly, and time will be lost instead of gained. The speed should be regulated so that the articles will have time to slip about and slide down upon each other as much as possible. If the barrel turns too fast, they will hug the sides of the barrel and be carried around with it; about 40 to 50 revolutions is correct; if too slow, the action is unnecessarily prolonged.

Tumbling barrels are of all sizes and several kinds, made up of iron and wood—some made of wood and lined with iron. For small, light work any ordinary hard wood barrel or keg may be used, by having it mounted on a suitable frame and a door cut in the side to admit the work. Many barrels are octagonal in shape, and give good results. A barrel which is much larger in diameter at its center than at its ends will act quicker than one that is of the same diameter throughout, as it gives the contents a double motion, from ends to center and from sides to center, causing a thorough mixing and rubbing together of all the pieces contained therein, cleaning and polishing the contents quicker and better than any other shape. It runs with less noise, because the contents are moving in two directions at the same time, doing away with that slamming noise which is a feature of straight barrels.

Where small castings or stampings are quite rough, it will be found advantageous to use a small quantity of tripoli or powdered pumice in the first rolling. After the roughness has been removed, a very high polish may be obtained by rolling the work for two or three hours in a barrel half or two-thirds full of very small leather scrap, such as may be obtained from a shoe factory. Greasy or oily scraps should not be used, as they lack the polishing qualities of the dry leather. Small work, such as small castings, stampings, screws and rivets, may be given a very fine polish and bright luster in this way. Small work which is to be plated in baskets will require no further cleaning, except rinsing in hot potash.

Small articles that are nickel, brass or copper plated in large quantities and require buffing or polishing afterwards may also be rolled in leather, but the leather must be clean and the barrel must have a sufficient quantity of work and leather in it to make it roll smoothly and not fall from side to side; in other words, it should be full. In rolling plated work, the time it should be left in the barrel will be gauged somewhat by the thickness of the plating; usually ten to fifteen minutes is sufficient to obtain a high polish; if allowed to remain too long in the barrel, the plating will be polished off. The more leather you have in the barrel the longer it may roll and the better the polish will be; but if insufficient leather is in the barrel, the work will hug the sides of the barrel and the plating will be cut through.

Saw dust is useful in the tumbling barrel; it is not a very good polishing agent, but for removing and absorbing oil and grease from work from the machine shop, it is a valuable assistant to precede the potash; in fact work which can be rolled in sawdust will not require potash unless it is to be plated.

There are barrels made for rolling castings in water. In these a stream of water is applied to the barrel and withdrawn from it through the hollow trunnions on which the barrel is mounted. The water applied to the work helps to remove the sand from the castings while not allowing them to tumble so hard against each other, thus giving less wear on elevated portions of the design of the castings and making a more even job.

Another barrel in extensive use on small work is the oblique barrel, with the end open and the whole weight carried by one end of the apparatus. Some of these are made to run in one position, while others are adjustable to several angles. Work may be polished in these barrels either wet or dry. The advantage claimed for the adjustable barrel is that the lower the angle the more violent will be the motion of the castings in it, while as the work proceeds, raising the barrel a little from time to time reduces the amount of motion of the work, so that the final polish is given with a very small amount of motion, the barrel being nearer vertical. These barrels are also made with a lever that permits of throwing the barrel forward and dumping out the batch of work. For wet polishing a little water is put in with just enough of a good soap powder to make a good thick lather; enough soap must be used to make a good lather, or the polish will not be satisfactory. After being sufficiently polished, the work is dipped out into the plating baskets, rinsed in hot potash, then in water and hung in the plating tanks. Small articles that have been plated may also be polished in this way instead of buffing.

Necessity of a High Finish.—It is one of the cardinal principles in plating—and probably always will be—that an object which is required to take a high finish and bright polish after being plated must possess a high finish before it goes into the plating solution; this rule applies generally to all classes of plating, with one exception, that being work which is gold or silver plated and burnished afterwards. In this case the plate may be burnished down into small scratches or lines, thus hiding them, but for all work which is finished on the buff or felt wheel the above rule applies. Every plater has often been asked if the plating would not fill up this flaw or that scratch. The electro-deposit fills up nothing in the way of defects; all flaws are seen in the plate as plainly as they were in the original. True, an article may take a high polish after being plated over scratches or other defects, but that will never remove them; they are still there. So, in order to have a perfect finish upon the plated articles, there must be a perfect base to work upon. It has been claimed by some that a heavy coat of copper from an acid or duplex copper solution upon iron or steel work finished upon a 120 emery wheel, may be polished down by buffing to hide the emery marks and thus render unnecessary the operations on the 150 emery and grease wheels; but this does not cover these scratches; it merely brightens the object, so that the marks are not so perceptible.

CHAPTER IV.

ACID DIPS AND PICKLES, THEIR COMPOSITION AND USES.

Pickles are preparatory conveniences; they greatly facilitate the work of preparing the rough castings, stampings or forgings for the finishing processes of polishing or plating. There are some classes of work which do not need acid pickles in their preparation for the plating bath, such as soft metal and small novelty goods, which receive their preparation in the tumbling barrel; also some small brass, bronze and German silver goods which are to have their entire surfaces polished for a final finish, or for plating. But for the great majority of articles of copper or its alloys, or of the various grades of iron or steel, which are required to be either polished or plated, suitable acid pickles will be found of great value, from an economical standpoint, in the saving of time, labor and polishing material.

The quantity of pickle that can be used to advantage will depend upon the class of work and the amount of it that is to be handled at one time. A vat or jar that will just allow of the right amount is better than a larger one, as large vats are harder to handle and there is trouble in recovering lost pieces which have dropped to the bottom of the tank. A fresh pickle made up as soon as the last one shows signs of becoming exhausted will do quicker and better work than one in which the acid is nearly all spent, so that the work is attacked slowly and perhaps unevenly in some cases. With the small vat the loss is also less in case of leakage or a broken jar. Experience in the plating room has proved very often that time is the most expensive thing the plater has to buy and it is better to keep pickles and dips as small as is practicable, and to renew them frequently, rather than to make larger ones and attempt to run them a longer time, as a partly spent pickle works at a much slower rate.

For small pickles, stoneware jars may be used, (except with the hydrofluoric acid pickle), or square stoneware tanks may be obtained from the dealers in plating supplies. For heavy castings, stoneware has the disadvantage that it is easily broken by dropping a casting while putting it in or taking it out of the tank, in which case the pickle is a total loss unless it is quickly transferred to another tank, to say nothing of the great inconvenience of having the acid spilled over everything if the tank happens to be standing on the floor when the accident occurs. Liquor barrels sawed in two in the center and the hoops covered with asphaltum, make very good tanks for large pickles, while for very large work, special tanks should be made of two-inch oak, strongly bolted together and the exposed parts of the bolts well covered with asphaltum. Hydrofluoric acid pickles should be kept in oak tanks well bolted.

Small work is usually handled by means of stoneware dipping baskets, which have bales and are provided with holes of varying sizes, through which the acid drains when removing the work from the pickle, or, if baskets are not at hand, small work may be strung on copper wire and hung in the tanks until the work is sufficiently pickled. In doing this care should be taken that the work is wired so that the flat surfaces of the work will not lie upon each other in the tank and thus prevent the acid from getting at such surfaces freely. The work should be turned over and moved about from time to time so as to give the acid a chance to get at all parts of the work freely and thus hasten the process and keep the action as even as possible over all of the exposed metal. Castings should be removed from time to time and brushed with a stiff brush and wet pumice stone, to see if the sand and scale are loose and to remove as much of it as possible in this way. Or they may be taken to the lathe and brushed with a steel scratch brush and then examined, when if the desired result has not been obtained they should be returned to the pickle.

When the pickle begins to work slowly and is full of sand and mud, it should be thrown away and a new one made, as its strength is gone and it is useless. In throwing old pickles into sinks or waste basins, care should be taken to let large volumes of water through at the same time, in order to dilute the acid, especially where iron waste pipes are used, as if much strong acid is allowed to run through iron waste pipes, they will soon be eaten through, causing much trouble and perhaps damage to the contents of rooms below, besides the expense of frequently renewing the waste pipes.

When work drops to the bottom of the pickle it should be recovered with long iron hooks or tongs, never with the hands.

Pickling does not change the appearance of the work much, unless it is left in too long, when it becomes black and is covered with a greasy-looking oxide. It has been pickled long enough when the scale and sand are removed, or loosened, so that they may be brushed off; when this has been accomplished the work should be at once removed from the tank, washed well to remove the acid, dried and sent to the polishing room.

The ordinary pickle does not give off gas to any particular extent, so that no particular precautions are necessary in regard to ventilation, except in the case of the hydrofluoric acid pickle, for which a hood and forced draft should be provided.

Fresh acid and water may be added from time to time to tone up a pickle and make it work faster, but when it becomes black and muddy it should be thrown away and a new one made.

Every practical polisher and plater knows that the iron or brass casting that is properly pickled to remove all scale, sand, grease and oxides, can be polished and finished in one-half the time, at less than half the cost for polishing material, than would be the case if the pickles were not used. In fact, in some cases, it would be next to impossible to do a satisfactory job of polishing without first removing the scale.

But pickling, like everything else, can be overdone and work may easily be ruined by remaining too long in them. Iron castings, especially those of gray iron, when left in the pickle too long, are liable to become spongy and porous upon the surface. In this case it will be found very difficult and often impossible to remove the effects of the negligent pickling by polishing or tumbling as the case may be. The acid, by long undisturbed action upon the castings, removes the sand and other foreign matter from the pores of the casting and then forms a black, greasy scum of oxide upon the metal, which is removed with difficulty, only to expose the porous and perhaps spongy surface of the casting. In extreme cases of this kind, it is usually labor lost to finish such a casting, as the spongy surface extends so far into the metal that it is next to impossible to remove it by polishing and if it were accomplished it would probably cost more than it would be worth, while the life and shape would be polished out of the article, so that it would never be a satisfactory piece of work, either of polishing or plating, as you may depend upon it that what the polishing wheel will not remove the plating solution will not cover up.

It is also very difficult to give good adhesive qualities upon plating which is done on over-pickled goods. Where the surface of the work is left spongy when it goes into the bath, there is always a considerable amount of acid which penetrates the surface of the work and will remain there until the action of the current forces it out into the solution. Thus it will be seen that plating much of this work will play havoc with the nickel solution, which soon becomes too acid, causing the plating to become very brittle and hard, so that it blisters and peels without any apparent cause. In such a case, where the plater has been very particular to clean his work thoroughly, he is frequently at a loss as to where the trouble lies. Many platers suppose that potashing such work thoroughly and using the cyanide dip when preparing it for plating will remove all traces of acid from the pores of the castings, but they are mistaken. Cyanide and potash do not have the penetrating powers of the acid and consequently do not reach and neutralize it in the pores of the metal, so that it remains there until forced out by the current in the bath, where it causes trouble.

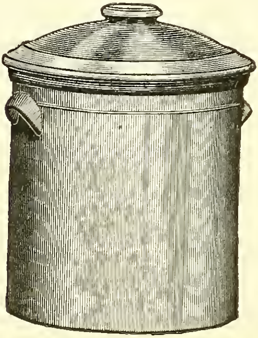

Fig. 28. Jar for Pickles and Dips.

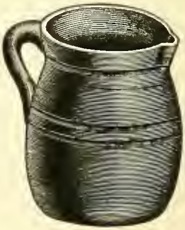

Fig. 29. Acid Pitcher.

The effects of over-pickling are somewhat different, but just as troublesome, in cyanide baths. The current will force out the acid as in the first case, and when it is freed, it combines with the cyanide upon the surface of the work, making a surface upon which a perfect and adhesive plating is impossible. The continued plating of such work will greatly reduce the specific gravity of the solution, by reducing the cyanide, making the distribution of metal in the solution uneven, and causing no end of trouble which is usually assigned to some other cause than the correct one.

One other point should be mentioned in this connection; that is the practical certainty that over-pickled articles will rust. Work which may look all right after plating and buffing will peel off after a few weeks, or at the most a few months. When this happens the base metal will show the pores of the metal and will have a black and unnatural appearance.

Taking all these things into consideration it will readily be seen that it is better economy to throw any over-pickled work into the scrap pile at once, as such castings can never make a satisfactory finished product.

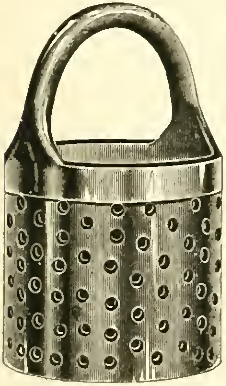

Fig. 30. Dipping Basket,

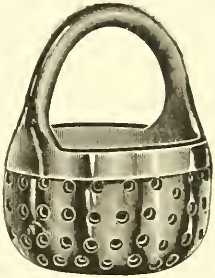

Fig. 31. Dipping Basket.

PICKLE FOR IRON.—For a quick-working pickle on rough iron castings use sulphuric acid 1 part, water 4 parts; for a slower acting pickle intended for smoother castings and stampings use sulphuric acid 1 part, water 10. The water may be increased still more if desirable in pickling very smooth pieces where very little sand or scale is present. The pickle in everyday use for castings and wrought-iron goods is composed of:

Sulphuric Acid	1 part.
Water	4 parts.

The acid should always be added to the water slowly, with constant stirring; never add water to acid under any circumstances, as their mixture is attended with great heat and if the water were poured into the acid the resultant heat would convert the water into steam, which would blow drops of acid upon the workman who is doing the mixing, causing serious burns; if the acid happened to be in glass the unequal heat of the mixture would break the glass and the escaping acid would set things on fire.

This pickle is generally used cold, but when large quantities of work are to be pickled and time is an object, it will hasten the operation if the pickle can be kept at about 150 degrees F. This is done by placing the pickle jar in a tank of water kept hot by a steam pipe.

The length of time the work should remain in the pickle depends largely upon the condition of the work itself and also upon the condition of the pickle, as a moment's consideration will show that the action of the pickle is that of sulphuric acid dissolving iron in the presence of that proportion of water which gives the acid the greatest facility of working over considerable periods of time, and a new pickle will consequently work much faster than one in which the acid is more or less spent (combined with the iron of previous castings). Some castings are comparatively smooth and free from sand and hence do not require as much pickling as those which are very rough and sandy. On some forgings, where the scale is very thick and hard, pickling is required for as much as two or three hours; even then, in extreme cases, the scale may have to be partly removed mechanically, with a sharp tool, or the point of an old file.

In putting large quantities of work into the pickle at once, care should be taken to stir the pieces and move them about from time to time, so that the most exposed parts may not become burned while those surfaces which are covered or lying against each other are not pickled at all. In such a case you have an unsatisfactory job all around, part of the piece being pickled too much, part not at all, and the main object in pickling has been defeated. The idea in pickling is to easily and quickly remove the roughness of the scale and sand, so as to present a smooth surface over all parts of the work and it should be handled in the pickle in such a manner as to accomplish that object with the least expenditure of time and acid, removing the work from the pickle as soon as each piece is free from scale.

HYDROFLUORIC ACID PICKLES.—Hydrofluoric acid may be used to considerable advantage, instead of sulphuric acid, where the main object is the removal of sand from the castings. For a strong and quick acting solution, use:

Hydrofluoric Acid	1 part.
Water	15 parts.

For a slower acting solution, the quantity of water may be increased to 30 parts.

The work should be allowed to remain in the pickle from fifteen minutes to an hour and a half, according to the amount of sand to be removed. Hydrofluoric acid dissolves silica very readily and also most of its compounds. The most common form of silica is sand, and the most common compound of silica is glass; hence this acid has extensive use in etching on glass and it cannot be kept in glass bottles. A hydrofluoric acid pickle attacks the sand on the casting and dissolves it, while the sulphuric acid pickle attacks the metal around the sand and leaves the sand free to fall off, which it does as soon as the casting is turned over; it will be seen that the action of these two pickles is directly contrary to each other. The hydrofluoric acid pickle may be used to great advantage upon either brass or iron castings where the removal of sand is the prime object. Great care must be taken in using this acid. It must be kept and used in wooden vessels, as it would soon destroy earthenware or glass. Care must be taken not to get it upon the hands or clothes, as it causes sores which are very difficult to heal.

There must be good ventilation to carry off the fumes, which are poisonous and extremely detrimental to health. Oak tanks may be used without lining, or they may be lined with asphaltum or sheet lead.

DIP FOR IRON.—For removing rust from iron or steel goods of any kind, a dip of pure muriatic acid is used. Where the goods are not very rusty, four or five minutes will usually be sufficient; if badly corroded, from ten to twenty minutes will be required; but this dip will remove the rust, no matter how thick, without hurting the metal, if the work is removed and thoroughly rinsed first in cold, then in hot water and dried in sawdust as soon as the rust disappears.

MURIATIC ACID PICKLES.—A pickle for the removal of scale from iron is sometimes made by the substitution of muriatic acid for the sulphuric acid in the pickle given previously, but the results are usually not as satisfactory as with the sulphuric acid pickle.

BRIGHT DIP FOR IRON.—Work which has been pickled in the ordinary way, to remove sand and scale, afterwards dipped in hot water and dried in sawdust, has a dull black appearance. If the work is to be polished, the black will be removed and the color restored in the process of polishing; but if it is not to be polished and is to be plated, or if it is to be left with parts of the iron showing, the work should be run through the bright dip. This will bring it out white, improving the appearance if it is to be left unfinished, and tending to make it take a whiter deposit if it is to be nickeled. This dip is composed of:

Sulphuric Acid	24 ounces.
Nitric Acid	10 ounces.
Metallic Zinc	2 ounces.
Water	2 gallons.

Place the water in a stone or earthenware jar; then add the sulphuric acid slowly, with constant stirring; cut the zinc in small pieces and throw it in; then add the nitric acid slowly, with constant stirring, and allow it to stand for a few hours before using.

Work that is to be dipped should be strung on copper wires so that flat surfaces do not lie together, swirled about in the dip for a few seconds, rinsed in cold water then in very hot water, and dried in sawdust. Articles should not be allowed to stay in this dip for any length of time, as they would be spoiled and the dip ruined. All water must be gotten out of hollow articles before dipping, and all acid and water after dipping or it will spoil the dip in the first instance or tarnish the work in the second.

Brass or bronze goods that have been brazed, such as picture frames, buckles and novelties, have left upon them a thick fire-coat which must be removed before they can be bright-finished in their natural color. The ordinary pickles remove this coat slowly, but it may be removed almost immediately by dipping the goods into pure nitric acid (the power of the acid may be lessened somewhat by adding a few ounces of common salt) and then rinsing at once, to remove all acid. Then the work may be potashed, dried, dipped in the bright dip, rinsed in cold, then in hot water, and dried quickly in clean, hot sawdust.

BRIGHT DIPPING.—A bright dip is one which is designed to obtain radically different results from the dull, or satin finish dips. It is so composed that the metal, while corroded, is not covered with a dull sub-oxide, but remains bright enough to reflect the light more or less from the innumerable points left by the acid, so that while we have a matted surface, it leaves the metal bright and shining but not polished. This is a favorite finish with brass workers, as it adds greatly to the effect when placed alongside of brightly polished work. Speed of operation and uniformity are the essentials in bright dipping, as the acids act very quickly and the longer the work is allowed to remain in the dip the more corroded and larger will be the granulation of the surface of the metal and the duller will be the effect produced. Another very important point is the ability to keep water out of the dip without unduly slowing the output of the work. Water will convert a bright dip into a satin finish dip, if present in a very small quantity, thus destroying the dip as it will no longer give the best results as a bright dip. If much water is present the action will be greatly increased in those portions of the dip which contain the water, and as the work is never in the dip long enough for the water to become evenly distributed, when some of it has been carried in on the work, the result will be that part of the surface shows much larger granulation and duller surfaces than those portions which were in contact with the acids only. Bright dips are used to obtain two or three distinct effects, which depend chiefly on the amount of time the acids are allowed to work upon the metal; a second or two will give a bright effect; twice that length of time will give a very bright surface; while six or seven seconds will give a comparatively dull effect which is almost a satin finish. This time is given for a new dip which is working rapidly upon metal which is very easily corroded, such as the brass generally used in gas fixtures. As the dip gets older, the time must be increased to obtain similar effects, and metals which are less easily attacked must also have longer time. If the potash and rinsing water are near the boiling point, the metal will be dried quicker and will go into the dip hotter than if the rinsing water or potash were not so hot, and the amount of heat retained by the metal when it enters the dip will have an effect upon the work, as heat hastens chemical action in a very marked degree. It will be seen from the foregoing that no definite directions can be given for bright dipping, which is probably the reason that most writers on the subject content themselves with giving the bare formulae, and leave the plater to work out his own salvation as best he can.

The bright dip for copper, brass, bronze or German silver is:

Sulphuric acid	100 parts.
Nitric acid	75 parts.
Common salt	1 part.

Large solutions may be made up in the proportions of:

Sulphuric acid	4 quarts.
Nitric acid	3 quarts.
Salt	Small handful.

After dipping the articles should be very quickly rinsed in cold water, then in hot water and dried in sawdust. Boxwood or hardwood sawdust must be used; soft wood sawdust will not do, as it tarnishes the work badly.

There is a similarity between dips and pickles in that they are both composed of acids, the difference being that the dips are usually composed of acids without any weakening, while the pickles are composed of acid and water, varying according to the circumstances of their use.

There is a right and a wrong way of preparing the various kinds of work for pickling and dipping. It may be stated generally that work which is to be dipped should be dry and free from grease. It is the usual practice of platers when bright-dipping brass or bronze goods to first hot potash them, then dip into hot water, swing in the air until dry, then immerse in the bright dip, then into clean running water, then in boiling hot water and finally dry in sawdust. This seems to be the proper method, except that it will be found more advantageous to swing the work dry from the very hot potash and transfer it immediately into the bright dip, not using the hot water before bright dipping at all. In this way the potash dries quickly upon the surface of the work, forming a film which protects it from the air while being conveyed to the bright dip. Hot water will not do this, but will draw away from parts of the metal and the action of the air on such exposed portions of the work oxidizes it, causing a surface which will not dip evenly. You are bound to get more or less water into the dip by the former method, and this must be avoided in order to obtain the best results, while by using the hot potash alone you avoid the possibility of getting water into your dip and the potashed work presents a better surface for the acid to attack, as it is more uniform, thus producing brighter and more even results in the finish, while the potash is immediately destroyed by the action of the acids without producing any apparent weakening of the dip. The addition of water in a very small quantity will render the dip useless for first-class work. If the plater will try using hot potash and exclude water entirely before dipping he will not revert to the old way of doing things.

Care must be taken to keep the different dips and pickles from getting mixed with one another. Work that must go from the pickle to the dip or from one dip to another should be rinsed in running water and hot water and swung dry before going to the next dip, as the drippings of one dip or pickle getting into another very often cause trouble.

If much of this work is to be done it should be performed in a separate room or shed, or if that is not convenient the dips and pickles should be kept in one place and have a projecting hood over all of them with an outlet through a chimney to draw off the acid fumes, or it would be better still to have the pipe leading from the hood fitted with a suction fan. The vat containing dips and pickles should be boxed in with the hood with a sliding door in front, which can be shut tight at the close of the day's work, as when the fan stops running the acid fumes would fill the room and tarnish and rust all metal goods and machinery. This is, of course, for large establishments which are doing the same class of work all the time, such as gas fittings, brass beds, harness trimmings, furniture trimmings, cabinet hardware or other lines which have a standard finish for their work, which is obtained by dipping and which have enough of it to make it profitable to fit up properly for the health and comfort of the men. The small jobbing shop using a dip of ten gallons or under will not go to this expense, and such dips should be kept in earthen or stoneware jars, which are made for the purpose and provided with closely fitting covers of the same material. Such dips should always be kept covered when not in use, both for cleanliness and to keep the fumes of the acids from contaminating the air of the plating room.

Satin Finish Dips.—While it seems almost unnecessary to define so common a thing as the term "satin finish" has become in the plating and jewelry trades, still we will do so for the sake of completeness, just as we have particularized on other things in a way that is totally unnecessary to the man who is at all competent in the business. The object in writing at all is to tell those who are daily entering the business the reasons of the things they see as daily matters of course, very often without in the least understanding what is going on before them, because everything seems to be taken for granted by those about them and they are ashamed to ask for fear of being thought dull of comprehension. Satin finish in plating is generally used to define the appearance of an article which, instead of being polished all over, is finished as if it were to be bright, and is then given a very finely matted appearance. This is accomplished in several ways—in the acid process it is accomplished by dipping the bright object into a composition of acids which will evenly corrode it all over, giving a dull, matted surface, which is even and smooth to the eye, but is without gloss or shine; it is made by holding the object in the sand blast; and also is produced on soft metals by scratch-brushing all over with a steel wire scratch brush, before or after plating. It varies in the amount of the luster allowed to be retained by the bright metal from none at all to a very perceptible shimmer, which shows through the dull surface produced on the metal. Very beautiful effects are produced by thus varying the amount of sheen allowed on the object and the expert satin finisher is able to produce a depth of color and a softness which are exceedingly effective when the articles are to have a final dip, which gives another color than that which is due to the metal of which they are composed, as, for instance, in giving a black or gray finish to copper or gun metal work, watch cases, etc. Satin finishing is almost entirely a matter of personal skill and experience, as is generally the case with the simplest processes. The object to be attained is, first of all, evenness of finish, not only on the object itself, but also on all of the entire batch of work to be done. This is not so easy as it looks; not only must the work be perfectly clean, so that the acids will take hold evenly, but the operator must have a strong sense of time, as the acids take hold instantly, and a second or two longer in the bath will make a very appreciable difference in the appearance of the finished work; the amount of swirling or moving about in the bath will have an effect on the evenness and amount of corrosion; the speed with which the work is passed from the dip to the rinsing water and the amount of water used to rinse in will show also; a fresh dip will work faster than an old one which has spent a portion of its strength; the heat of the metal, which is dipped hot from the potash or rinsing water, will also affect the speed of the corrosion. Now a moment's study will show that two persons will rarely perform all these operations exactly alike, and this is the reason why one plater will rarely be able to finish satin-finished or bright-dipped work exactly like another, and this difficulty will increase with the number of dips which must be given in finishing the work. It is for this reason that the dipping is usually given to one man in an establishment, as it is more important that the work shall be finished alike than that it shall be the finest attainable. Skill in dipping consists in watching all of the points mentioned above and in being able to perform them with a machine-like regularity, so that a dozen or a gross of work shall not have marked differences in the final finish. This is especially the case with small work, which is turned out in quantity, thrown in a heap and put on cards in dozens afterward, as it would not do to have a difference in finish in one or two articles on a card of one dozen. It would also show up prominently if the sugar bowl of a tea set were satined more or less than the other pieces of the set. When we come to the French grays, browns and blacks, slight differences in dipping have results which are very marked in the finished goods; and the difficulty is vastly increased if it becomes necessary in refinishing shop-worn goods to match those which are already on the shelves. Only practice, and lots of it, will enable a man to finish evenly, while careless persons will never learn to do it because they do not take account of small fractions of time in the various operations connected with dipping for a desired result.

Brass work requiring a satin finish may be dipped for a few seconds into a mixture consisting of:

Nitric acid	1 part.
Water	3 parts.

Then dried and run through the bright dip to give it a luster. If they are not satined enough the operation may be repeated. Another satin dip is composed as follows:

Sulphuric acid	2 parts.
Nitric acid	1 part.
Muriatic acid	½ part.
Water	5 parts.

After which the work may be rinsed, dried and run through the bright dip, if necessary. Still another satin dip is:

Sulphuric acid	2 parts.
Nitric acid	1 part.
Water	10 parts.

After dipping in this the work should be bright dipped.

ORMOLU FINISHES AND DIPS.—An ormolu finish is an imitation of a twenty-two or twenty-four karat gold color on yellow brass. It has extensive use on gas fixtures and also on furniture trimmings, lamps, clocks and bronzes, as in all these cases the pure and brilliant yellow shows up very effectively against their darker surroundings and adds materially to the effectiveness of the ornament. The color most desired is a bright, clean, clear, golden yellow, which must be perfectly even and brilliant, but not polished. The name is French and means "ground gold." It was originally obtained by fire-gilding brass, which was of the same color as the gold, but has been imitated successfully by dipping, until now we find that manufacturers who are still gilding their work to obtain the original and more durable finish call such work "gold ormolu." Any tinge of red in such work must be rigidly excluded, as the faintest shade verging on copper will completely destroy the effect desired; so also is the case with the paler shades which come from the zinc in the brass, although they are frequently accepted as ormolu by those who do not know the difference. When properly dipped to just the right color and degree of matting and thinly plated with gold in a bright plating solution, with a current so regulated as to avoid all tinge of red and exactly match the brass under the gold, it gives a softness and velvety yellow which have never been equaled by any other finish on objects for which it is suitable. It must be soft and at the same time brilliant; too much brilliance will make it look hard and brassy, while too much matting will make it look heavy and dull; in either case the color is a surface color only, while with the proper softness and brilliancy it seems as if the color extended below the surface of the object and the hard, metallic look is gone.

The ormolu dip may be used on bronze, oreide or copper, and produces a very rich, soft, velvety finish which is handsome and lasting when lacquered.

There are many ormolu dips in use, some giving good results, while others are not so good. We will give first those which are in most common use and give the best results. It is considered good practice to run some classes of work through the satin dip before putting them through the ormolu dips in order to increase their evenness of finish. One thing which must be borne in mind is that absolutely no water should be allowed to get into the ormolu solution, as this would cause its ruin, so that pains must be taken to see that the work is thoroughly dried before going into the ormolu, and it should be rinsed off quickly afterward, first in cold and then in hot water. Sometimes it is necessary to use the bright dip after the ormolu, if the finish is considered too dull or dead. After the work has attained the proper finish it is rinsed in clean hot water and dried immediately in hot sawdust, dusted off and quickly lacquered with ordinary brass lacquer, to which a few drops of gold lacquer have been added in order to get the same shade of color as the ormolu. This is the usual method of handling the cheaper classes of work, such as gas fixtures, furniture trimmings, etc. The better classes of goods, such as clock ornaments and fancy lamps, are dipped in the same way, but instead of lacquering after receiving the ormolu finish, they are given a very thin plate in a bright gold-plating solution, keeping the color as near the shade of the ormolu as possible by proper regulation of the current. Then a burnisher is run over the high-lights of the ornament in order to give a high polish on these parts and bring out the contrast of the ormolu in the matted parts of the background. After this the work is ready to be lacquered with a lacquer as near the shade of the finished work as possible.

An ormolu dip in common use and which gives satisfactory results is composed of

Sulphate of zinc	5 pounds.
Sulphuric acid	15 pounds.
Nitric acid	15 pounds.

Muriatic acid	5 ounces.
Salt peter (nitrate of potash)	1 pound.

In preparing the above add the sulphate of zinc to the sulphuric acid; then add the salt peter, which should be pulverized; stir well; add the nitric acid slowly, with constant stirring; finally add the muriatic acid in the same manner; stir thoroughly and let stand for some time before using; to be used hot.

Another ormolu dip which gives general satisfaction and is not so complicated as the previous one is as follows:

Nitric acid (chemically pure)	1 gallon.
Sulphuric acid (chemically pure)	1 gallon.
Metallic zinc (scraps)	¼ pound.

Dissolve the zinc in the nitric acid by adding it slowly; this should be done where the fumes may be carried off; then add the sulphuric acid slowly and stir well. This dip must be used hot. The jar containing it should be set into hot water, but great care should be taken to allow no water to come in contact with the dip, as there would be considerable danger of the acids flying, as previously referred to, besides spoiling a dip composed of expensive acids. If the work comes out too bright add more zinc scraps, slowly, making sure that they have all dissolved before adding more, as it is easy to get in too much. If it is too dull add more nitric acid, stirring well and giving it time to become well mixed, for the same reason.

A third ormolu is given below:

Sulphuric acid (C. P.)	1 gallon.
Nitric acid (C. P.)	½ pint.
Muriatic acid (C. P.)	½ pint.
Saltpeter	6 pounds.

Pulverize the salt peter and place in the jar which is to contain the dip; then add the sulphuric acid and stir until the salt peter has been taken up; add the nitric acid slowly, with constant stirring; finally put in the muriatic acid slowly, with constant stirring and frequent pauses in the operation to get rid of the heat; this work should be done in the open air or in a well-ventilated room. Finally stir up well and let stand for several days before using. This solution gives the best results after it has been in use for a time.

In using dips two things are of importance. These are good ventilation and a good supply of water, both hot and cold. Where the bright dip is not too large, say one in a five or ten gallon crock, it may be set in a vat of running water, on bricks if necessary, to bring the top of the jar several inches above the top of the running water. The outlet of the vat should be an overflow stand-pipe, as described elsewhere, and when dipping the water should be allowed to run continuously in order to carry off the acid, as the work is rinsed in the running water just outside the jar. The water would soon become strongly impregnated with acid if the water were not kept running, and this would tarnish or discolor the work after it was bright dipped and rinsed in the acidulated water. Plenty of clean, cold water and also plenty of clean, hot water are essential in turning out good bright dipped work. Hot water that has been used for rinsing work from cyanide solutions will tarnish the bright dipped work and should not be used. By being particular about these details of cleanliness is the only way in which first-class work can be obtained in the process of bright dipping.

WOODEN SHOES.—Where the amount of pickling and dipping is very large and the work is passed rapidly from one dip to another, or swung dry from the potash and hot water, the floor about the pickling and dipping tanks frequently remains wet constantly; in bad cases the entire plating-room floor is so damp and impregnated with chemicals that a workman whose shoes are a little thin in the soles has wet feet almost constantly and a bad cold, rheumatism, etc., are likely to be the result. Many a good man has refused to work in a place for the reason that the floor was kept constantly wet to such an extent that his health suffered from it. For such places a modification of the well-known Dutch wooden shoe has found considerable favor. This is a shoe having a leather upper and a wooden sole, of whitewood, about two inches thick, which is further raised from the floor by being shod at the sides and front of the sole and at the heel with iron, so that it will not cause the wearer to slip, even if the sole is wet. Such shoes, though rather heavy to wear until you get used to them, are of great value in such places, as they keep the feet dry and will save their owner from ruining many a fine and high-priced pair of shoes, as is done in the plating room every day. These shoes may be obtained of any dealer in platers' supplies, and their use is steadily growing as the platers become aware of their advantages.

CHAPTER V.

THE ARRANGEMENT AND MANAGEMENT OF THE PLATING ROOM.

Whenever it is possible the plating room should always be on the ground floor, or if plenty of good light and ventilation can be obtained in such a location, it is still better to have it in a basement. Light and ventilation are of the first importance and other considerations are generally sacrificed to obtain them, if it is necessary to do so in order to get them. But if other considerations permit of a choice it is better to have the plating room in the basement, for several reasons. In large plants where considerable acid dipping is done, there is the necessity for specially constructed waste and sewer pipes. These should be of either lead or copper, lead, being much the cheaper, is generally used; but copper stands the corrosive action of acids and alkalies passing through it as well as lead and has the advantage of being much more easily taken apart and removed for cleaning in case it becomes clogged. These pipes should be of good size, at least two inches in diameter and larger if possible, and special attention should be paid to laying them, in order that they may have as few turns and bends in them as possible; care should also be taken to see that they do not sag at any portion of their runs, as all such places will form pockets for the retention of corrosive liquids and sediment, which will soon eat through the pipe at all such points and make its renewal necessary much sooner than would occur with waste pipes which are properly laid. Vitrified sewer or conduit pipe properly laid is better than either, where it can be used, but it must be plenty large enough and laid in such a way as to permit of taking apart for cleaning, if it should become necessary, as many plating shops have been shut down for a considerable time by a clogged sewer pipe, which prevented the use of running water in the many rinsings which are an indispensable part of the business.

Of course, the nearer to the ground or to the main sewer the plating shop is located, the smaller will be the plumber's bill for changing the ordinary iron pipes to those of lead or copper. Iron waste pipes are absolutely useless in extensive plants, especially those which are located above the ground floor, as they are continually being eaten through and causing no end of trouble and inconvenience in the shop, as such things generally happen at a time when it can be least afforded and brings the whole plant to a standstill until the difficulty is remedied. Furthermore, iron pipes rust so badly when used for such purposes that it is next to impossible to remove them in order to make repairs when necessary; connections and elbows often have to be broken and cut off in such cases, generally causing considerable expense, profanity and loss of time.

Another reason for having the plating room on or as near the ground as possible is the danger of leaking tanks, the boiling over of potash or hot water tanks and the overflowing of cold water tanks, which arises from the overflow pipe becoming temporarily clogged up while the water continues to flow into the tank, as is the case in the busy plating shop. Overflows frequently occur in many shops and are seemingly unavoidable with the average personnel which is found in the trade. Where other shops or industries are located under the plating shop, leaking tubs and defective waste pipes very often cause the occupant of the floor below considerable annoyance and damage for which the owner of the plating shop is liable, to say nothing of his loss of sleep and peace of mind after he has paid a round sum for damaged goods.

These annoyances can be practically prevented if before the plating plant is installed care is taken to put in the proper kind of waste pipes and a water and acid-proof floor.

FLOORS.—There are several kinds of floors adapted to this purpose. One is to lay sheets of galvanized iron on the floor, so as to entirely cover the ordinary floor of the room; solder the edges of the plates together carefully; turn up the outside edge about an inch or more; just outside of this edge nail a board or cleat, so as to support the edges, thus forming a huge pan which is the full size of the plating room. This is next covered thoroughly with hot asphaltum and given a liberal coating of fine gravel or coarse sand while still warm. When this becomes thoroughly cool, it is ready to have the tanks put in place and the room fitted for work.

Another very good floor is made by using roofer's tar paper, using several thicknesses, instead of zinc or galvanized iron, turning up the edges in the same way, and letting each strip overlap the preceding one about six inches and then applying hot tar and gravel or sand as before.

Perhaps the best and most serviceable floor is the Portland cement floor. This should have the roofer's tar paper underneath and the board or cleat at the edge should be from two and one-half to three inches in height, in order to allow of a liberal quantity of cement, which is mixed, one part of cement with three or four of torpedo sand and water, spread smoothly over the paper and allowed to harden. Gutters or drains may be made about the room, in the floor, to carry off the waste water.

Where these cement floors are used a very good arrangement is to have the upper end of the main drain pipe terminate in a cement pocket or trap, which is funnel-shaped and has its edge even with the top of the cement floor, so as to form part of it. This pocket should be about eight inches deep and say eight inches in diameter. It should have a sieve or screen of wire at the bottom and should be near the cleaning water tanks, so that all waste pipes may discharge into the funnel above the screen. These pipes may thus be easily removed in case of clogging. When it is desired to clean the room, loose objects may be removed from the floor and the hose turned on it and the floor thoroughly washed, the refuse being washed and swept down to the funnel. Afterwards a boy may insert his hand in the funnel and remove all wire and litter which has been caught by the screen.

If the preceding suggestions are carried out, the plating room may be safely located upon any floor, providing expense is no objection. It is said that a good line fence between farmers makes good neighbors; so a good floor in your plating room may or may not make good neighbors, but a leaky one will surely make bad ones. While the above arrangement may seem expensive, the expense is all in the first cost, and it will seldom or never need repairing.

TANKS AND VATS.—A few years ago it was thought necessary to have all wooden tanks and vats used in the plating room lined very carefully with sheet lead of considerable thickness and all joints in the lining carefully burned, no solder being permitted. This added greatly to the cost of the tanks and was attended with some distinct disadvantages, such as the greatly increased weight, making it necessary to strengthen floors under them in many instances, and the fact that if the anodes or work touched the lining accidentally, the latter, being a conductor of electricity, would divert the current and cause considerable trouble until the difficulty was found and remedied. In many such cases work which was being plated had to be taken out and refinished, as the current was off the work so long before the plater found the trouble that it was spoiled in the tank. Indeed, some old-timers still insist that lead lining is the proper thing. The modern plater, however, holds the belief that lining tanks with lead is simply money thrown away, as it gives no better results than the modern method of lining them with asphaltum and cheesecloth.

The best tanks are made from well-seasoned pine, from two to three inches thick, according to the size of the tank, with tongued and grooved corners, and with iron rods on the ends. The rods should have nuts on one end, to draw them up tightly, as the wood will dry out considerably after it is well lined and in use for some time in a dry, steam-heated room. If it is a large tank, the bolts should be put through the bottom, horizontally, and also perpendicularly through the sides, so that they can be drawn up as shrinkage occurs. In vats of twelve feet length or more, a good, strong 2x4 should be nailed across the top before the solution is put in, in order to prevent bulging at the sides, which would open the tongued and grooved joints at the corners. It will help matters a great deal in regard to possible leakages in use if a good-sized quarter round strip be well nailed in the corners and along the sides of the bottoms of these tanks before proceeding to line them, as experience has shown that the corners and seams are the places where leaks generally occur and the better we can make this joint in the beginning, the less likely is it to give trouble afterwards.

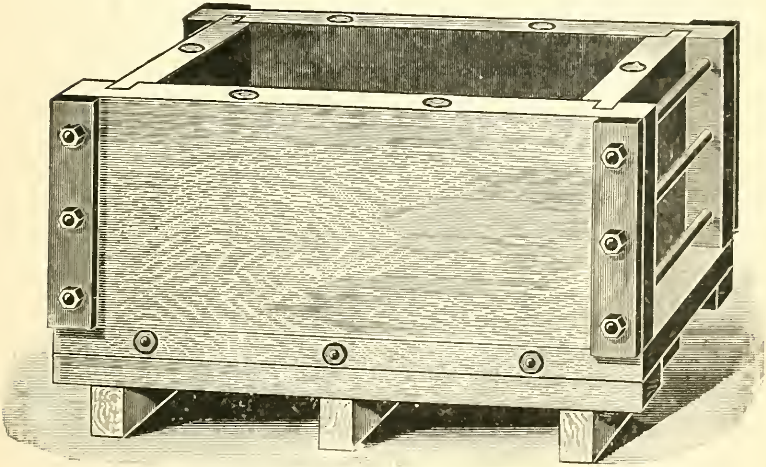

Fig. 32. Tank for Plating Solutions.

On account of the great weight of solutions in large tanks, it is extremely difficult to keep them tight when made of timber and used for large work, as the constant movement of the floors on which they are supported tends to rack them until they open at the corners or along the bottom, generally at the corners. These tendencies have led those who must use large tanks to consider various substitutes for wood, of which to make them. Probably the best of these substitutes thus far in use is the cement tank. It can be made of any size in one piece, and if well made, and particularly if well supported, as when resting on or in the ground, it will be to all intents and purposes a solid stone vat which will never cause trouble by leakage or breakage or rot. The merits of the cement tanks are spoken of very enthusiastically by those who have tried them. They are in use in the copper refineries of Northern Michigan, in the works of the Luxfer Prism Company in Chicago, and in various other places where large permanent tanks are desired. In the copper refineries they are used without lining, being made smooth on the inside by a facing of cement, similar to the finish usually found on the ordinary cement sidewalk. Some of the others have left out this cement facing and lined the rough cement with the ordinary composition of pitch and asphaltum which is used for lining the ordinary wooden tanks. When so made they will stand acids and alkalies as well as any other tanks which are similarly lined, and it is claimed that the roughness of the unfinished concrete furnishes a very good anchor for the lining, so that it will not slide down to the bottom of the tank nearly as soon as the wooden tank lining will. The large tanks in question have all been made to rest partly in the earth of the shop, a large hole being cut in the floor, a suitable excavation made for the tank, and the tank built into the place which has been thus provided for it, so that a six-foot tank will project above the floor about two feet. This is a very convenient method, as it obviates having to raise heavy pieces very high when hanging them in the tanks, while they project far enough to prevent any danger of work or other substances falling or being accidentally swept or washed into them when cleaning up the room. Such large tanks are open to the objection that they cannot be moved when built in this way, but the objection amounts to but little, as such tanks are seldom moved anyway, unless the lease of the premises is expiring, and the safety from leakage and from accidents caused by dropping heavy pieces into them is such as to many times repay the loss caused by having to leave the old tank in position and build a new one when changing the location of the shop. These cement tanks are also being made in smaller sizes and the following description of the method of their manufacture by David H. Browne, in the Electrochemical Industry, is so complete that we reproduce it herewith:

The first requisite is a good, slow-setting cement. Slowness of set is necessary because in building large tanks it requires ten or twelve hours or even more to carry up the walls to the required height, and as the ramming must be continuous throughout this entire time, it is evident that if the bottom took its initial set before the sides were completed it would be injured by the vibration. The cement, therefore, should take longer to set than the tank to complete. Cheap cement is worse than useless. Saylor's cement has proved a reliable article, but any brand which will stand the "pat" test will be satisfactory.

The "pat" test is made by mixing a handful with water to a stiff paste and working the same on a glass plate into a cake about half an inch high and 3 or 4 inches in diameter. The surface should be troweled smooth and the sides brought down to a thin edge. This is allowed to stand a few hours, then is covered with a wet cloth and set aside in a cool place over night. If it sets slowly and shows no cracks on the surface or at the edges it will answer.

For the best work crushed granite should be used. This has a rough granular fracture or "bite," into which the sand and cement lock better than with any other rock. As the stone used is the weakest part, and as a good concrete, when broken, shows fracture across, and not around the particles of stone, it is important to use the best rock available. Failing granite, a trap rock or blue diorite is a good subsuitute. The size of the rock depends on the thickness of the walls; a safe rule being that no piece should be over one-quarter the thickness of the wall in which it is used. For ordinary tanks material passing through a screen 1½ inches, and over a screen of ½ inch is satisfactory. The material smaller than ½ inch should be rejected, as it interferes with the filling of the voids.

The solidity of concrete depends largely on the care with which these voids are filled. To determine the void space, take a pail of crushed rock, calculate the volume and find the weight. Add now water till the pail is full and weigh again. Calculate the volume of the water and simple proportion shows the empty space between the particles of rock. This space must be filled with sand, of which in turn the voids must be filled with cement. The voids of cement are in their turn filled by the water absorbed. Hence for strong concrete the common use of the formula, "4 parts rock, 2 parts sand, 1 part cement." For less careful work a larger proportion of rock is often used.

To mix the cement a tight mortar box or floor and a measure holding one cubic foot are needed. The rock should be thoroughly washed, and the sand screened from clay or gravel. One cubic foot of cement to two of sand is mixed on the dry floor to an even composition, and to this four cubic feet of stone are added, and the mass thoroughly shoveled over. Water is now added, so that, while no muddiness is apparent, each particle is moist. The mass is again shoveled over and is now ready for the mold.

This mold may be of any shape whatever. It is set on a solid floor, with a sheet of building paper underneath so that the tank does not bind to the floor. The sketch shows a form for a commercial-plating bath. The outer frame is trued at right angles and braced by struts to the floor to prevent bulging of the sides under the rammer. The concrete is now shoveled in, a few inches at a time, and thoroughly rammed until the water shows at the surface. For a tank of the size shown three men are needed ramming and two men mixing and handling concrete. The tools needed are iron rammers, about 2 inches thick and 3 or 4 inches square, with a sleeve for a wooden handle. Such a tool. handled with a short, stiff blow, is better than a lighter tool, with a springy blow, the idea being simply to drive out the air from between the particles and completely fill the voids.

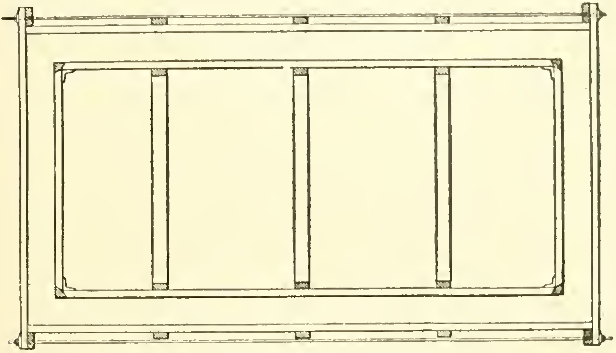

Fig. 33. Tank Form for Cement Tanks.

As soon as the bottom is of the desired thickness the inner frame is put in place and braced by cross pieces to prevent inward bulging. The sides are now rammed up, a few inches at a time. It is not desirable to lay the sides in layers, but rather to carry them up without coursing or stratification. One thing is very important, that there be no stoppages. If a meal time intervenes the men should be relieved one at a time, so that no pause occurs till the tank is completed.

The top finish is put on by bringing the concrete to within a quarter of an inch from the top of the mold and carrying this up with equal parts sand and cement troweled to a smooth surface. Any openings or holes in the tank wall are made by inserting a block of wood of the desired size in the side walls. After the tank is set the wood can be drilled or broken out.

Three or four days should elapse before the moldboards are taken down. The inner frame is removed by unscrewing the angle irons shown, when the side boards will drop inward without any difficulty. The outer form falls apart on removal of the tie rods. If necessary the inner surface can be finished with a coat of sand and cement, but if planed boards were used for the molds the surface is usually quite smooth.

Concrete will not stand strong acids; caustic or chlorine has no effect upon it. A coating of paraffine or tar would help it to resist acids. It should not be subjected to sudden changes of temperature. If the heat be brought up gradually it will stand fire. It can be handled or lifted like a block of granite if ordinary care be used to prevent the tools from bearing against the sharp edges of the tank.

A tank with 6-inch bottom and 4-inch sides, containing 24 cubic feet of concrete, can be set up and completed by five men in one day. The cost decreases with the number of tanks built at one time and the facilities for handling concrete. Building four tanks of this size per day the cost per tank was as follows:

Carpenter and blacksmith labor on molds	$ 1.75
Concrete work labor, 30 hours at 17½c	5.20
3.5 cubic feet cement at 60c	2.10
7 cubic feet sand	.25
14 cubic feet crushed trap rock	3.00
	$12.30

Including finishing, taking down molds, cementing in rubber-pipe connections, about $15 will cover the cost of building a tank as above described, the dimensions of which are about 3 feet wide, 9 feet long and 2 feet deep. No construction of lead, slate or wood can be made which will fulfill all the requirements of the case for this sum.

The costs as given are remarkably low, but are given for the sake of the information which they contain as to time, material, etc., necessary for a tank of the size given. In cities this cost would be at least doubled and it will probably vary with the locality in which the work must be done, the cost of cartage for material, etc. If there is a cement contractor in the neighborhood it would be undoubtedly better and probably cheaper to let him build the tanks, rather than for the plater to undertake to do it himself, as experience counts in cement work, even more than in plating. One other point should be emphasized, even more than the writer has done—that is, the absolute necessity of slow drying in order to secure a good, strong job, which will not have a tendency to crack or peel after it has been some time in use. Probably every plater has seen cement walks which have been in use for years without showing any defects, while others have gone to pieces in far less time; this is because the one was made with plenty of water and kept wet for several days, while it was setting, and thus hardened very slowly and evenly, while the other was in use, exposed to the heat of the sun and the strains of traffic within a day or two of its completion. It will be the same way in building tanks; if allowed to set properly—that is, slowly—the strength will be much greater than if they are rushed through and quickly dried.

Slate is also coming into favor for tanks, as its chemical constitution is such that alkaline solutions have almost no action on it, and it is being used extensively in the manufacture of chemicals by electrolytic processes in the east. Slate for this work must be free from mineral veins, soft enough to permit working freely and possess sufficient resisting properties to enable it to withstand the action of alkalies. The writer has seen the plating tanks of a large watch factory in New England made of this material. It gave excellent satisfaction, was very cleanly, and being a non-conductor of electricity and easily worked, the installing of the various rheostats, conducting wires, switches, etc., was one of the neatest and most convenient jobs we have ever seen. All fitting must be very carefully done in this material, however, as while very strong, it is not very elastic and cannot be sufficiently compressed to force a tight joint with poor fitting.

Lining Tanks.—The ordinary lining for plating tanks consists of asphaltum with a little pitch in it to make it a little less brittle. Do not attempt to save a little money on tank linings by making your own, as it will certainly cost you many times the amount saved in leaks and spoiled solutions later on. The proper composition for tanks has been worked out at a considerable expenditure of time and money by others and it will certainly be cheaper for you to buy their experience than to go over the ground again for yourself, at your own cost. Another point in lining tanks is that it is poor economy to try to get along with a thin lining less than a quarter of an inch in thickness. You may apparently line your tank so that it is tight with a lining that is only a sixteenth of an inch thick in many places, giving more at the corners. Three months later you are apt to find your solution is lost in part and you have got to reline the tank, all of which could have been saved by lining properly. Another point is that the lining has a tendency in time to slide down into the bottom of the tank and will do so in hot weather or in a very warm room in winter, unless it is very securely anchored to the sides of the tank. In lining small tanks, it is a good plan to take a gouge and go all over the sides with it, making deep cuts in the sides, but leaving the chip in the cut. This forms a very good anchor for the lining when it is melted and poured in. The tank should be very dry when the lining is put in, so that it will penetrate the wood and hold on to it. If not dry the water will be turned into steam in the wood and prevent the lining from adhering, and when this occurs you do not discover it until the tank is in use. In lining large tanks it is customary to anchor the lining to the sides by the use of cheese cloth in the following manner:

Fold the edge of the cheese cloth and tack it tightly in one corner of the sides of the tank; stretch it evenly along the side until you come to the next corner; make another fold here, tack through the fold liberally and proceed along the other sides in the same way, giving double thickness at the corners and leaving cloth enough to lap over on the bottom; continue the cloth past the starting point, so as to leave a double thickness there; do the same with the bottom, tacking closely at all the sides and corners. Now tack along all the edges and liberally through the cheese cloth all over the sides, so that these points will offer resistance to the weight of the lining and prevent it from coming down when the tank is in use. The point is that the lining if it is as thick as it should be, has a considerable weight and a consequent tendency to leave the wood and slide down when it gets warm, as it will do in a very warm room, and there should be enough tacks in the cloth to prevent this. Lining with cheese cloth is practiced on all wooden tanks with a capacity of one hundred gallons or more.

Asphaltum for lining is purchased from any dealer in plating supplies and may be secured in any desired quantity. It is usual to order one pound for every gallon of the tank capacity. Large amounts are shipped in kegs and barrels, smaller portions in any convenient package. It is black and solid, weighs about 300 pounds per barrel, and must be melted in applying. This is generally done in an old iron pot which is large enough to hold a sufficient quantity to cover the largest side of the tank with one melt, as it saves the trouble of making a joint in the side with a hot iron, which must be done if you cannot cover it all at one time.

It should be melted slowly with stirring until it will run very freely and there are no lumps left in it.

Lay your tank on its side, with a batten nailed along the top of the tank, projecting as far as you want the thickness of the lining to be, say three-eighths of an inch, so that when you have leveled the tank you can pour in the melted asphaltum until it covers the side of the tank to the thickness of the batten. If the tank is small, pouring the lining in this way will be all that is necessary, provided the lining is hot enough to run all over the sides immediately and find its own level while cooling, so that it is level and smooth as glass when it has cooled. If it is too big for this, or if it is lined with cheese cloth as described above, it will be necessary to have a hot flatiron, pour on plenty at a time and iron it into the cheese cloth—or rather through it—and into the wood, adding more asphaltum and ironing steadily until the air has all been worked out of the cloth and we have a hard, thick, smooth coating as first described. When this side has been accomplished to your liking, let it cool while heating a fresh lot of asphaltum for the opposite side; then turn the tank and repeat the operation, doing the ends next and finally the bottom. Pay particular attention to the corners; if in doubt about these, take no chances, but stand the tank on its corner after cooling and pour in hot lining and follow with a hot iron, keeping at it until you are sure that the lining has melted into one solid piece at that point. Successive layers covering each other here will not do; it must be one solid piece. A tank well lined in this way will last for years without leaking, particularly if the quarter-round moulding of good size has been used as described, so that twisting of the sides and bottom of the tank, caused by uneven settling or springing of the floor will not open the corners. A half-inch lining is generally thick enough for all but very large tanks. But do not try to save a dollar in lining a tank; every dollar saved here will certainly cost you fifty later on.

Concrete tanks made as described previously should be dried as thoroughly as possible and the lining put on with brushes and then carefully ironed on with a very hot iron, keeping at it until the lining is smooth as glass. It need not be as thick as for wooden tanks, as there will be no twisting and wrenching of the sides and bottom of such a tank, so that all that is necessary is to see that there are no faults in the lining which would permit the solution to reach the cement.

There is a marked difference in tank practice in the east from that generally followed in the west. Eastern platers order the tanks lined by the dealer of whom they buy and such tanks are sanded with clean white lake or river sand before the lining cools. This is done to harden the outer surface of the lining. A western dealer never lines a tank; tank and lining are shipped separately and the plater lines the tank himself after it gets into the shop, so as to take no chances of cracking the lining in shipment; this could be easily done by a jar or blow or a fall in shipping, especially in cold weather, as the asphaltum is then very brittle. The western plater likes to see his lining as smooth as glass; the eastern man wants his sanded, claiming that it is stiffer and not so liable to slide down. On the other hand, it is harder to clean. As several thousand tanks are in daily use that have been lined either way, it is apparent that either method will answer.

When possible the acid dipping jars and the jars for the various pickles and dips in more or less constant use should be arranged in a large wooden tank of shallow depth. The size would necessarily depend somewhat upon the amount of work to be done and the amount of room which could be afforded; but in a large job shop where various kinds of plating and finishing are done constantly, a tank two feet deep by four feet wide and ten feet long would be of convenient size. This should have a partition through the center, with a water cock projecting over one corner of each half of the tank and a standing overflow pipe in the opposite corner. The tank should be made of two-inch stock and provided with the plumbing fixtures shown in Figs. 34 and 35. These are readily purchased at any plumbing shop and either pattern will do, although Fig 34, shown with the projecting plug, is the most convenient, as the overflow pipe may be attached with the least trouble. In this case a standing overflow is made by soldering a piece of pipe to the hollow plug and cutting it off so that the water will overflow into the top of the pipe at the designed depth, which is generally about six inches less in height than the depth of the tank. If the fixture spoken of cannot be obtained the other, Fig. 35, will do; in this case, discard the plug and grind the bottom of the pipe so that it will be water-tight when inserted in the mouth of the fixture in place of the plug. These fixtures come in regular sizes to fit the piping, varying by quarters of an inch. Care should be taken not to get the waste pipes from this tank too small, as it is sometimes necessary to empty them very quickly in case a pickle jar or dip has been upset, or in case a sudden change of work requires absolutely fresh water in the tank. In the latter case valuable time may be lost while waiting for a 100-gallon tank to empty and refill, if the pipes are too small, besides the greater freedom from stoppages of work caused by clogging of the waste pipes, which is much more likely to occur with small pipes when the standing pipe is pulled and sediment

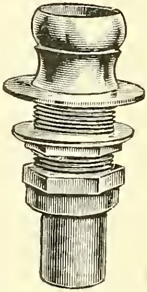

Fig. 34. Plumbing Fixture for Standing Overflow, showing Ground Hollow Plug to receive standpipe.

or dirt allowed to flow into the waste pipes from the bottom of the tank. Smaller than two-inch pipes should not be fitted here, for the reasons given, and two and one-quarter or two and a half inch will be far better, on account of the saving of time when emptying and the increased freedom from clogging. The drainage is short and the expenditure has to be made but once, while the saving of time is constantly recurring and the labor using the tank is high-priced. The hot side of the tank should have a steam pipe open at the bottom and reaching nearly to the bottom of the tank. This pipe should be of sufficient diameter to heat up the water quickly, when work requiring hot rinsing is being done. The steam must be clean and should come direct from the boiler, if possible; it will not do to use exhaust steam, as that contains oil, while the rinsing water must be kept clean; and the pressure must be such as to heat the water to the boiling point. Much time is lost in the wages account by neglecting this point. There are many shops where plating cannot be done for an hour or more after starting work in the morning, because there is not steam

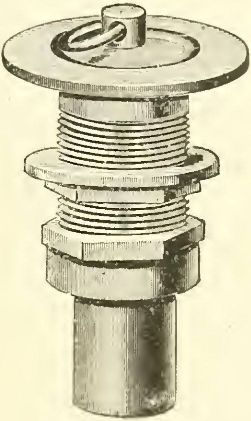

Fig. 35. Plumbing Fixture for Tank bottom, to which standpipe may be fitted.

enough to heat up the potash tank properly, so that the owner loses in reduction of output many times the cost of proper fittings every month. This loss is greatly aggravated in cold weather, many shops not getting up speed in such weather before ten o'clock in the morning, during three or four months of the year. There should be steam enough to heat a hundred-gallon tank in a half hour, so that work may be started quickly. Then, when once warmed up, the steam supply is cut down and no more is used than is

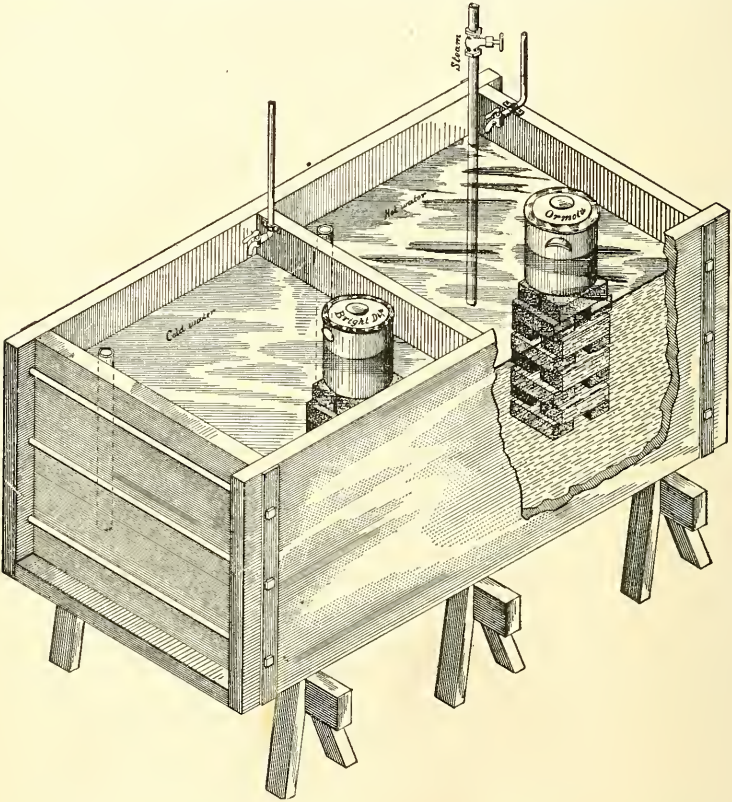

Fig. 36. Pickling and Dipping Tank, showing jars in position for work

required. A one inch lead is generally sufficient for this purpose, unless the pipe is very long and it is left without covering or other protection.

The jars containing pickles and dips are set in the tanks while they are being used and the rinsing is done just outside the jar; this is clearly shown in Fig. 36. If the jars are small, they may be used in a deep tank by making a pile of bricks which will raise the top of the jar far enough to prevent water getting into the jar, while the temperature of the dip is kept at the proper point by the water. Care should be taken to pile the bricks solidly, especially on the hot side, as a strong flow of steam causes considerable commotion in the water and it may upset the jar if the supporting pile of bricks is weak. If it is upset into the tank, pull the standing overflow pipe out and empty the tank as quickly as possible.

The silver strip, oxidizer and ormolu jars are generally used on the hot side and the bright dip and pickles on the cold side of the tank. When using any of these, the water should be allowed to run continuously, as then the dirt and grease from the work are carried off at the top, through the overflow pipe, and the large body of water in the tank is kept constantly clean and ready for use. Unless this is done, the water will quickly become acidulated from the acids carried into it when rinsing from the dip, or similarly polluted from the cyanide and potash and in either case it will spoil the work. Clean, running water must be constantly used when doing the various rinsings previous to and after dipping.

As many of these combinations of acids used for dips and pickles are strong enough to emit dense fumes, which are poisonous and highly corrosive, particularly when freshly made up, they must be kept closely covered when not in use, or they will rust tools, discolor the conducting copper, armature commutator, and all bright metal in the room, besides endangering the health of the employes.

If the establishment is large and the dips and pickles are numerous and in large jars, they are generally kept in the tank we have described and a hood is built over the tank, having its outlet up a chimney, or provided with a forced draft by a suction fan, such as is used in the polishing room, but smaller; this will carry away all the poisonous fumes, prevent tarnishing the finished work, and enable the employes to work with efficiency and comfort. Shops which are on the ground floor often do their acid dipping outside, or in an open shed, when it can be arranged conveniently, but this plan is not to be recommended, as a contrary wind will often cause more discomfort in the shop than if it were conducted in the plating room without the forced ventilation spoken of, and with open windows. In any event, the situation may be helped materially by taking care to keep all dips and pickles covered when not in use, with plenty of running water and open windows when using.

Of even greater importance, because more frequently used, are the hot water and potash tanks and the scrubbing tanks for the plating solutions. These tanks should be in the middle of the plating room, where possible, with the plating solutions arranged on either side, with passage ways around three sides of the plating tanks. In this way it will be only a step from the rinsing and scrubbing tank to any solution and the work is hung before it has any chance to dry off and become spotted with dirt, as has happened in plants where the rinsing and scrubbing was done at one end of the room. This may seem a minor point, but speed in passing the work from one process to another is absolutely essential many times in the plating business, particularly when handling metals which oxidize quickly and are difficult to plate.

The potash tank is generally of iron, riveted up from tank or boiler plates, or cast, and stands on the floor, with no means of emptying it from the bottom. They have been made with a cock in the bottom, but it was found that in emptying the tank the cock would invariably become clogged with grease, wax, rouge and iron particles, so that the method was given up, and they are now emptied by dipping when it is necessary to clean them. The tank should have a coil of steam pipe in the bottom, sufficient to heat it quickly to the boiling point and too much is better than too little, as very often this tank must be hot before any work can be put into the plating tanks in the morning, so that it is not a question of expense here, but of being able to start work quickly. Seven-eighths or one-inch pipe is generally used here and enough coils used to cover the bottom. It should have a cold water cock above it, so that more water may be added without loss of the workmen's time, as the potash is constantly being carried out of the tank on the work and by evaporation it may be necessary to add water half a dozen times on a busy day. Crude potash, which is sold in drums, kegs or barrels is generally used, as it is cheaper and lasts longer than the more expensive and purer salts. About a half pound to the gallon makes a solution of good strength for most work, though it is sometimes used stronger and also weaker for special work. It should clean the work when dipped in it and swirled about, but it should not be strong enough to discolor the work too much, as it would necessitate too much scouring to remove the corrosion before hanging the work in the plating solution. Potash tanks are seldom cleaned, as the constant removal of their contents on the work makes it unnecessary to do so oftener than four or five times a year. Simply adding new potash and water from time to time, as may be necessary, will generally keep them up to working strength. Sometimes, however, when a very bad lot of work has been coming from the polishing room, the wax, soap, rouge and oil left on the work in the shape of polishing compound, cannot be skimmed off the potash and it must be dipped out and thrown away. Skimming is frequently necessary when working on certain kinds of work, such as that from automatic lathes, where the work is performed under a stream of oil, and also when oil has been too freely used in making stamped or drawn parts. If the oil used is animal or vegetable, the potash converts it into a soft soap and takes care of it all right; but if it is a mineral oil the potash will not saponify and can be removed by skimming it. In the latter case, the oil rises to the top of the potash and if not removed will cling to everything which comes out of the potash.

Cleansing solutions of potash or soda should be kept up to a desirable strength for the work at hand by the addition of fresh potash or soda from time to time. These solutions should not be allowed to become dirty, diluted or non-effective, as a great deal of the cost of producing good work depends upon the thorough and speedy cleaning, without which the work will peel. A weak, dirty cleansing solution is the source of no end of trouble and is often worse than none at all.

Where large quantities of both brass and iron goods are to be handled, it is advisable to have separate potash solutions for each, as potash used for cleaning iron goods will discolor brass, making it hard to clean without refinishing or buffing; brass goods which have been soldered will spoil potash for iron, causing it to take on a gray leaden scum, which must be thoroughly removed before plating. Zinc, lead, antimony or alloys, such as brittania, or aluminum, should never be cleaned in the same potash used for other metals, as it eats them away rapidly, and the other metals are then dipped in a solution of metal, instead of potash, so that the object of the dipping is defeated.

The hot water tank is of wood and generally stands close alongside of the potash. The end of the steam pipe from the potash coil is turned down into it, as shown in Fig. 37, and a separate steam pipe is also run into it, for use in case the steam passing through the potash coil is not sufficient; both these pipes have open ends and valves for control. On a cold morning the steam passing through the potash will be lukewarm water when it gets to the water tank, so that the live steam from the auxiliary pipe will speed up matters very profitably. The overflow pipe is made in the same way as already described for the dipping tank; it is subject to the same conditions and the same kind of fixtures

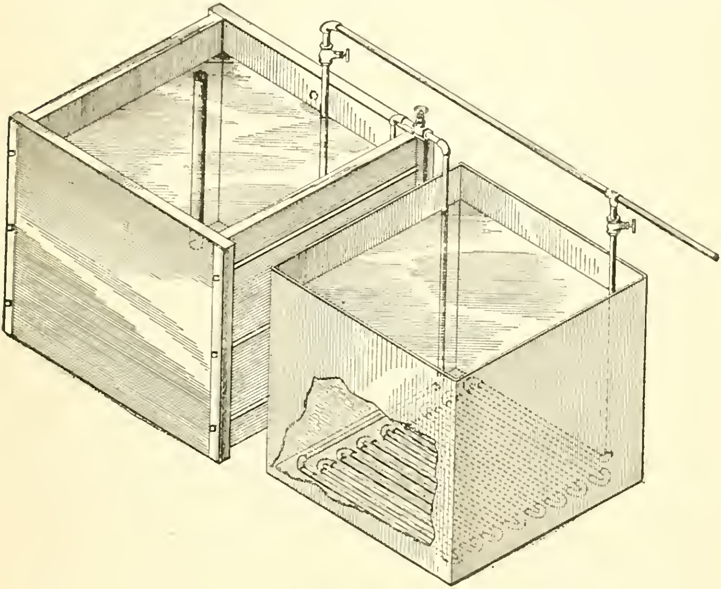

Fig. 37. Hot Water and Potash Tanks, showing steam connections and overflow.

are used. As both these tanks are frequently boiling, care must be taken that they are not filled so full that they will boil over; about six inches margin should be left in filling the tanks. They should be large enough to take the largest work the shop will handle. Two by three feet and two feet deep is a convenient size for the ordinary jobbing shop.

We have still the scrubbing and rinsing tanks to consider. These are made rather shallow, say eighteen inches deep, and provided with cold water only. They are generally on legs, so as to bring the top about twenty-eight inches from the floor, and have scrubbing boards on which to place the work while it is being scrubbed with pumice stone before going into the plating tanks. Fig. 38 shows a tank with a wooden partition in the middle and the running water flowing into the rear end of the tank. A hole is made in the wooden partition, just a little higher than the overflow pipe in the front end of the tank. The work is scrubbed with pumice stone and then rinsed in the front of the tank; it is then rinsed again in the clean water in the other half of the tank, thus allowing the use of the water twice, first to clean the work and then to rinse it. The economy of water is considerable in a large shop.

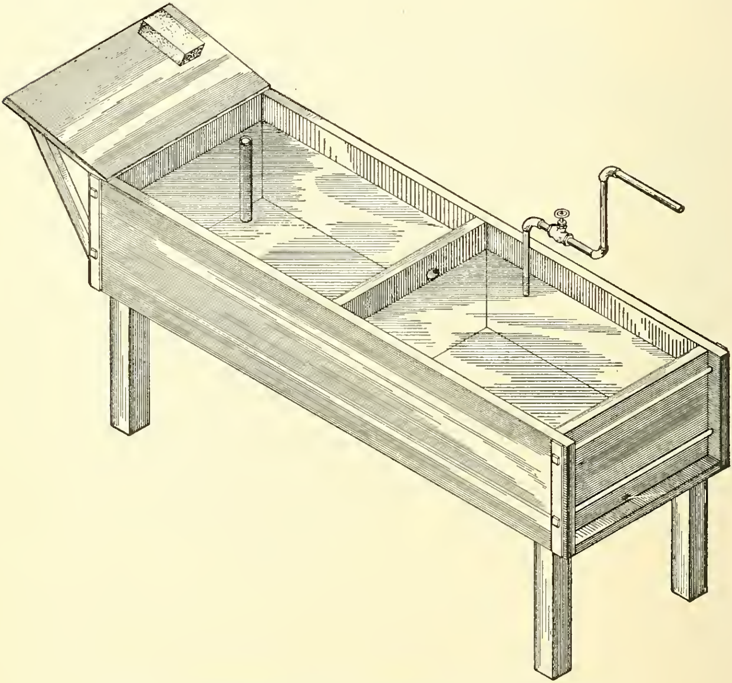

Fig. 38. Scrubbing Tank, showing use of water twice.

Fig. 39 shows a scrubbing tank, potash tank and hot water tank, in line. The scrubbing tank has scrubbing boards on each side; the work is scrubbed, rinsed in the tank and given the final rinsing in the large jar of clean water, which is shown setting under the cold water tap. This arrangement economizes space and still allows the use of the water twice, as in the previous instance, as the water falls into the jar and then overflows into the tank. The arrangement of the water pipes to serve each tank should also be noticed.

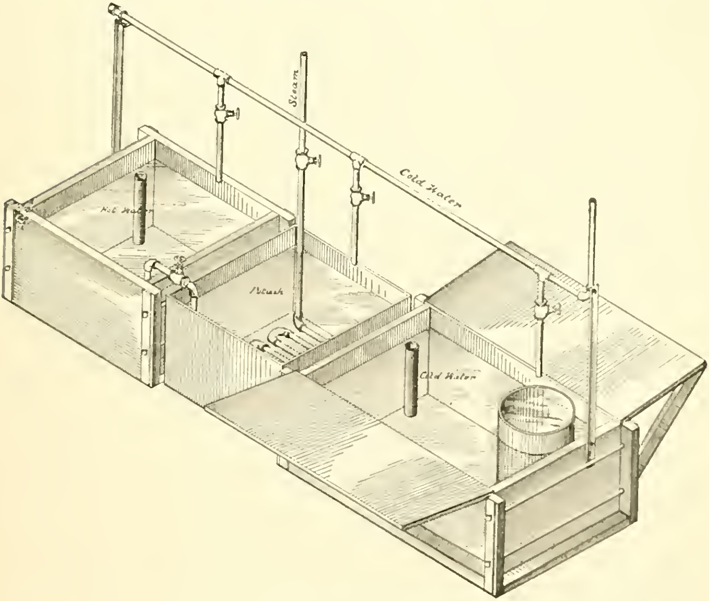

Fig. 39. Line of scrubbing, potash and hot water tanks showing jar for final rinsing.

All scouring and rinsing tanks should be cleaned out frequently. It is generally wise, where large quantities of work are being handled, to let out the water from such tanks each evening and then scrub them thoroughly with a hard brush and hot potash, especially along the waterline at the sides of the tank, as when much greasy work is being handled the dirt and grease will adhere to the sides and edges of the tank, where it will come in contact with the work being prepared for the plating vat and is bound to cause more or less trouble and annoyance in the work failing. After cleaning, rinse the tank and fill it with clean water. This should be done at the conclusion of each day's work. The sand and pumice stone found at the bottom of the scouring vat may be saved and used again on some kinds of work, such as rough castings and other work not having a polished surface. These settlings, however, should not be used upon finely polished work, as the sand and grit they contain will ruin the finish on such work.

COVERS.—All plating tanks and vats should have covers of wood, oilcloth or canvas; the two latter answer the purpose as well as wood and are more convenient to handle and take up much less room when not in use. These covers should be kept on all tanks at all times when they are not in use, as the grease and dust which are flying about will settle upon such solutions and stick to the work when it is put in the solution, making spotty work which must be refinished, or causing it to peel under the burnisher or after it has left the shop.

While the dynamo and tanks are covered the sweeping and cleaning should be done, either before uncovering in the morning or after covering at night.

Solutions should be skimmed off occasionally, with a suitable skimmer, to remove the dust and grease before hanging the work in the solution. Cyanide solutions will not require this operation very often, but nickel solutions have a tendency to form a greasy scum which must be removed each morning before hanging in the work, or it will cause spotted deposits, and the work is then very likely to peel off. To skim a solution easily and quickly, take a sheet of tissue paper by two corners, allowing the sheet to hang vertically, and drop its lower edge on the solution at one end of the tank, letting the sheet come down and float on the solution for about half the width of the sheet; then draw the paper slowly and evenly along to the other end of the tank and allow the balance of the sheet to settle on the solution, when, after standing a moment, it may be removed and thrown away, taking with it the grease and dust. Repeat the operation until the surface remains clean. A surprising amount of oil is sometimes removed from a solution in this way.

WATER.—Pure, clean water in abundance is essential in the plating shop, if the work is to be of good quality. Too little attention is usually paid to this point; any source of supply which is easily accessible is generally made use of, without regard to its quality, and if the results are not what is anticipated the trouble is ascribed to almost any other source than the water.

Where it can be procured, distilled water, made by condensing steam from the boilers, by allowing the steam to issue slowly in a barrel in the plating room, is undoubtedly the best for making solutions, as many of the metallic salts are easily thrown down by organic impurities in the water. If you doubt this take a little nitrate of silver and try to dissolve it in water from various sources which you know to have impurities in it. Then take a little more silver nitrate and put it in distilled water and see how perfectly it dissolves and how clear the solution is. A test tube will be large enough to try this experiment with and the silver may be recovered if desired by redissolving in nitric acid and evaporating to dryness. All metallic salts are not affected as readily as those of silver, and some kinds of impurities have more effect upon them than others, still the effect is there if the water be impure, and many times trouble has arisen when the source of water supply has been changed. For instance, in a large bicycle shop in Chicago the proprietors thought they would economize by sinking an artesian well instead of paying for water from the city mains; shortly after that their wheels began coming back from their customers because the nickel peeled in large patches or blisters. The trouble was finally located in the water, which was strongly mineral, but enough damage had already been done to have paid the city water bills for several years. Rain water from clean wooden tanks is very good for making solutions and other purposes where it can be procured, but if dirty it should be filtered, and this should be done with other water which is known to contain impurities which are likely to interfere with plating operations to any considerable extent.

It is also necessary to look carefully to the quality of the water used in rinsing and other plating operations, as this water and its impurities are carried into the solutions on the work.

Water with large quantities of lime in it will have an evil effect in time on some solutions, especially those of nickel. In this case the lime combines with the sulphuric acid and forms an insoluble sulphate, which either deposits on the work while being plated or falls to the bottom of the tank. If no further damage is done, the solution is being constantly robbed of acid, and it must be as constantly added to maintain the solution at its proper working strength. This state of affairs is much more common than is usually supposed in some localities where the water supply comes from limestone rock. Water taken from wells is sometimes found unfit for the best results in plating, if it contains much lime or is strongly mineralized with iron, sulphur, magnesia, etc.

Dirty water is absolutely useless in the preparation of work for the plating vat—that is, such water as would be obtained from streams or rivers into which the refuse and sewage from large mills and factories is drained, or into which the sewage from the city or town is allowed to empty. The waters of the Mississippi, Missouri and Ohio are very bad for plating on account of their muddy character at all times unless filtered at the city waterworks reservoir. When this water is allowed to settle a thick sediment of sand is found at the bottom of the tank, and in rinsing work to be plated more or less sediment will adhere to the work, often causing a roughness in the deposit.

Of course the reader must not assume that plating cannot be done with bad waters. It is done every day. These remarks are intended solely to direct the attention to a source of trouble which many old and experienced platers have never suspected, and also to emphasize the importance of securing a proper supply of water when establishing a new shop or removing an old one to a new location. Water conditions are very seldom ideal, and the only thing left the plater in most cases is to get the best that he can. Much may be accomplished by using settling tanks where the water is full of sediment, and in such cases the tank should be large enough to make sure that the outlet will not create a current in the water, but give the sediment time to settle.

STEAM.—The plating room should be supplied with steam enough to heat up the various tanks and vats quickly and keep them hot. In laying out the steam piping the main object should be to get steam enough to do the heating quickly in the mornings. This is a very different thing from getting enough steam to heat the tanks—some time, which is the plan on which your piping is likely to be put in if you allow the engineer to have his way. The pressure should be high enough to keep the pipes full of live steam at all times.

It is useless to fit up a plating room with half-inch or three-quarter inch pipe to heat large vats of water—say, from sixty to two hundred gallons—as sufficient steam cannot pass through such pipe in anything like a reasonable time. The first thing to do in the morning is to turn on the steam and get things warmed up before much work can be done, and it is both expensive and annoying to have a little half or three-quarter inch pipe sputtering away for an hour or more when ten minutes should be sufficient to get things boiling hot. When this has been accomplished the steam is turned nearly off, allowing just enough to pass to keep things hot.

There are several things to be heated in the plating room: First are one or more potash or lye tanks. These should have a steam coil in the bottom or along one side as desired. There should be two valves in connection with each potash tank, one previous to the entrance of the steam to the coil, in order to control its admission; the second should be on the pipe after it leaves the lye and before it enters the hot water tank. In this way the steam may be admitted by the first and checked by the second in order to hold it in the potash until it has given up most of its heat, whereas, if the second valve was not there, the steam would rush through the potash and carry nearly all its heat into the water tank. This is usually all that is needed in the hot water. Sometimes, however, a second lead of live steam is run into the hot water tanks in order that it may be heated up more quickly or independently of potash.

Then there is the sawdust box, which should be heated by a steam coil. The sawdust box should have a zinc bottom resting on the steam coil and the coil should be enclosed underneath by a false bottom of wood or metal, to retain the heat.

The tank where hot dips and pickles are used should have a pipe, preferably of copper or lead, run down to within three or four inches of the bottom of the tank and cut off. This is controlled by a valve above the tank.

There should also be an independent connection at some convenient point along the line where there is a vacant floor space if possible. Here the pipe should run out horizontally several inches from the main and terminate in a valve and drop; the latter should be long enough to reach the bottom of a jar or pail for use in boiling up solutions, or dissolving chemicals, when desired. By having a rubber hose which will fit tightly over this drop and providing its other end with three or four feet of pipe the steam may be taken around the room and used in any part of it as desired. This will be found extremely convenient in making up large solutions, warming them up on a cold morning, redissolving salts which have crystallized out of a solution which was allowed to get too cold, dissolving the incrustations on anodes and various other purposes.

Every tank, kettle or other steam connection should be so piped that it may be used independently of the others as much as possible, so that it will be necessary to heat only those which are in actual use.

In the preceding pages we have assumed that the plant was located where it could be served with steam from the same source from which it obtained its power for polishing and driving the dynamo. This, however, is not always the case. Plating shops are sometimes located where the power furnished is hydraulic. This is often the case in New England, where water powers are frequently used to drive for a number of small industries which are located in one building, or it may happen that all the power used is electric. This is coming to be the usual condition of things in cities which have companies organized to distribute and sell electric power, or in factories where the whole distribution of power is electrical.

Or it may happen that the boilers in the available source of power are already overtaxed and no steam can be obtained from them. In such a case substitutes will have to be provided. These are many and various. Often the plater will buy hog kettles for his potash tanks. These are simply furnaces with a fire place or grate under a large kettle, designed to be used by country butchers when scalding hogs; they are also used by stereotypers and metal refiners for melting lead, varnish manufacturers for boiling oil, soap makers and various other manufacturers. They are a nuisance in the plating room, as they must be fired constantly in order to keep the water, etc., hot, and the coal smoke and ashes are very undesirable in a plating room; but they are used where nothing better can be obtained, and work is being done by them in a number of small shops scattered over the country. It is much better in such cases to use one of the numerous forms of steam heaters which have been recently designed for the heating of private residences. We show such an arrangement in Figs. 40 and 41. In such a case the room may be piped as if for a regular source of supply, and the boiler may be placed in another room, or, if necessary, in the plating room. There is then but one fire to watch instead of several, and things

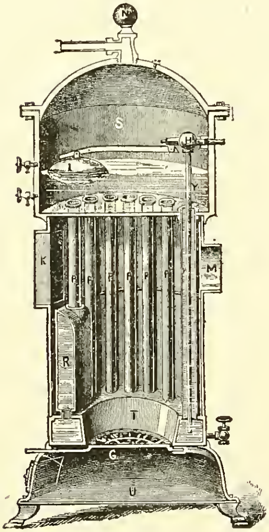

Fig. 40.

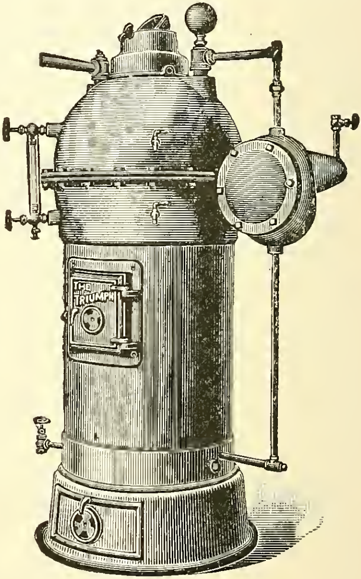

Fig. 41.

are kept much cleaner, especially if the boiler can be placed outside the plating room. Where city water pressure is available the float valve will take care of the water supply automatically, leaving only the firing to be watched. If this is not the case the water should be supplied from a tank placed higher than the boiler and piped to it as would be done with the city mains. In such a case the water level in the tank will also have to be looked after. This, however, is much cleaner and takes less time than the other substitutes for a regular steam supply. The writer has used one of these in a plating shop in Chicago and found it very satisfactory, except that it had to be fired every twenty minutes on a cold and busy day in winter. Plenty of steam was furnished, however, and we could start quickly in the mornings. These heaters are made by various manufacturers and are rapidly coming into use in various industries where low pressure steam is required, and many platers could materially improve matters in their shops by adopting them.

SUPPLIES.—In large plants it is usual to have a large cupboard or shelves in a laboratory in which to keep supplies. The cupboard is preferable and should be provided with glass doors, which will close tightly. The shelves should not be too deep, as in such a case supplies get pushed back behind others, and then more are bought, and perhaps waited for, when the desired material is already on hand, lying neglected and lost in a deep cupboard. One of the first things a plater does when taking a new position is to look over the cupboards and shelves and see what sort of a legacy his predecessor left him. Often he finds bottle after bottle partly full and covered with dust, paper after paper of old chemicals (many of them the same thing), pulled out of drawers and from shelves under benches, old boxes or the floor, etc. In one such case which was particularly bad, the plater simply collected everything; put them in order; dumped all papers containing the same thing in one new and clean package; did the same thing with the bottles, and then, having cleaned up to his liking, went on with his work and said nothing. One day, three months afterwards, the proprietor sent for him and asked:

"How is it that you never buy anything but acid? The other fellow had a bill every month, and you have never bought anything but acid."

"I am getting the work out all right, am I not?"

"Yes, but you don't buy anything."

"Well, I'm buying all I need," and he went back, laughing, to his work, unwilling to explain how he had found matters. The truth was he had found a stock of chemicals which, when straightened out and put in order, was sufficient to last him for over a year, and when he wanted anything he simply took it off the shelves instead of buying. The other fellow had no method of keeping supplies and had kept buying things he already had on hand. This is also frequently the case where the plater is the owner of the shop and thinks he is too busy to clean up, or do anything which can be neglected. Thousands of dollars' worth of chemicals are lost in this way by lying around until they are spoiled, when an orderly method of keeping them would prevent such waste.

Chemicals which are apt to deteriorate if exposed to the air are frequently bought in bulk. These are best kept in large, wide mouthed glass-stoppered bottles, called "salt mouths" by the druggists. Candy jars make good substitutes for the salt mouths if the latter are considered too expensive. The chemicals are at once transferred from their papers to these jars and the labels pasted on them. Then they will keep clean and fresh, are easily found when wanted and will dissolve much more quickly than if they had been allowed to dry out in papers. When possible it is better generally to buy in the quantities in which the goods are packed for sale. They then come to you fresh and in good condition, and you can keep them in their proper packages until used up. This can be readily done by finding out the various sizes of packages for each chemical and writing it down if not printed in the catalogue. Many platers have the very bad habit of ordering chemicals for which they have no use and of which they know nothing. This sometimes gets them into serious trouble and is expensive and annoying to the firm. Many chemicals are found in plating rooms which have no real use there and should be kept out. The simpler any dip or solution can be made, to give the desired results, the easier it will be to keep it in order and to understand if anything goes wrong with it.

Room and Light.—A great many shops are not well arranged for the production of good looking work cheaply and in large quantities, which is the main requisite when competition is so severe as it is getting to be, even where the plating shop is merely an adjunct to a factory.

I have found by experience in many shops that one of the main drawbacks is the woeful lack of room and light, both of which are prime factors in turning out good work cheaply and quickly. What I mean by room enough is, first, to have the plating room by itself and not have in one corner the lacquering, in another the polishing and buffing and in another the assembling and wrapping. Such a conglomeration is, I am sorry to say, often the case. As a result good work can not be obtained. The plating room should be separate, but convenient to the other departments, such as polishing and lacquering, and should be large enough to permit of passages on both sides of each tank, in which the plater may turn about easily.

As a general rule, the acids, dips, potash, scouring and rinsing tanks should be in the middle of the room, while the plating tanks should be placed along the side walls with one end near to the wall, so that the electrical connections from the main conductors to the tank rods may be conveniently made, without their interfering in any way with handling the work to be plated. This allows the plater to work conveniently at either side and one end of the tank, while furnishing a solid wall on which to place the electrical conductors, rheostats, etc., where they are secure and out of the way.

There should be plenty of room in the main aisles, between the cleaning tanks in the center and the plating tanks at either side, as here is where most of the work is done and the men should be able to pass freely with their work, without getting in each other's way.

By light is meant, of course, natural light and plenty of it. Any kind of artificial light is a very poor substitute for daylight in the plating business. It is a well known fact that one can not tell the different shades of gold or brass under artificial light; indeed, it is often hard to distinguish brass from copper, when they are polished, ready for plating, so it can readily be seen that it is next to impossible to watch fine colors, or to obtain the same shade on all the pieces of a lot to be gilded, brass or bronze plated. The plater must have a good, natural light, especially on particular work, as all artificial lights deceive the eye.

CHAPTER VI.

THE CONSTRUCTION AND MANAGEMENT OF DYNAMOS AND WIRING.

There is no department of plating in which improvement has been more rapid or has counted for more than in the construction and use of the dynamo. Starting with the machine of Edward Weston, in 1876 or 1877, which was the first low voltage machine to generally replace the batteries, the improvement has been constant, we might almost say continuous. When we take into account the facts that every manufacturer who sold a machine previous to 1890 had to educate the purchaser in its use and that none of these platers was either chemist or electrician, we might call this improvement marvelously rapid, as none of the dynamo builders were practical platers and all experience of its difficulties and defects had to come to them second handed, and with the person reporting them uncertain whether the trouble lay in the dynamo or in the solution. This difficulty exists to-day in many instances. Platers are slow to realize that electricity can be measured and controlled as easily as steam or water and they regard the instruments for doing it as useful refinements, suitable only for the laboratory, and not as so many valves and gauges, which they really are. The consequences are spoiled work, slow output, a totally unnecessary quantity of expensive metal in solution and any number of solutions spoiled by the addition of expensive and useless chemicals in a vain attempt to make them work, when the real difficulty lies in the electrical department.

An instance which recently came under observation will show the extent of some of these errors. A plater in charge of a shop doing musical instrument work was solicited by a salesman to purchase a voltmeter. He replied that he had bought one two years ago, but had loaned it and had lost it, adding that such things were of no use anyhow. The conversation drifted on to silver, when he volunteered the information that the general practice in making silver solutions was all wrong in regard to the quantity of metal that should be in them. Instead of two to four ounces to the gallon he was using seven and nobody had any better work than he was doing.

"Seven ounces!" said the salesman in astonishment. "What voltage are you using?"

"Four volts," replied the plater.

Now the salesman had been a plater and he could not reconcile these statements, so he asked the privilege of putting a voltmeter on the circuit. This was readily granted, and the silver tank showed three-quarters of a volt. In order to furnish proper conductivity for so weak a current he had put about two dollars' worth of extra metal in each gallon of a 500 gallon solution of silver and that money was lying idle in the tank, used only for conducting purposes. Yet that man did not need a voltmeter! He has bought one since, however. Another man in another shop uses twenty ounces of copper per gallon in the same way, and these practices could be cited in numberless instances.

Indeed, it is the rule that when proper instruments are put on the electrical circuit in any shop, that circuit undergoes marked changes at once and the practice of that shop is invariably changed for the better as fast as circumstances will permit.

These instances will show the nature of the misinformation which is generally supplied to the manufacturer of dynamos and against which he has had to contend from the beginning.

All plating machines were series wound for a number of years after their introduction, and many such machines are still in use. A series wound machine is one in which all the current generated by the machine passes through the windings of the field magnets and thence to the tanks. In a series wound machine the voltage is entirely a matter of speed. Any variation in speed, of course, gives a similar variation in the voltage of the current and therefore in its quantity. As they were driven at high speeds, from line shafts which ran much slower and also varied in speed according to the number of other machines they were driving, this difference of revolution of the line shaft would be multiplied by the number of times the dynamo speed was greater than that of the line shaft. Thus, with a line shaft running 300 revolutions per minute, driving a dynamo at 2,400, any variation in the speed of the line shaft would be multiplied eight times at the dynamo, and as the speed governs the cur-

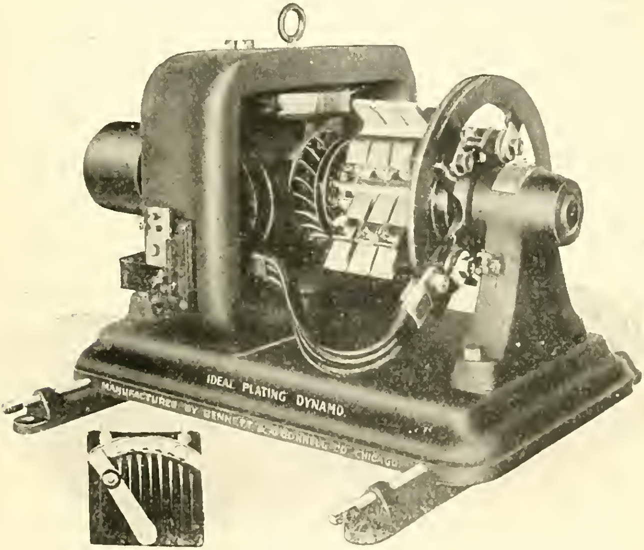

Fig 42. Multipolar Dynamo, and Field Rheostat for changing current strength.

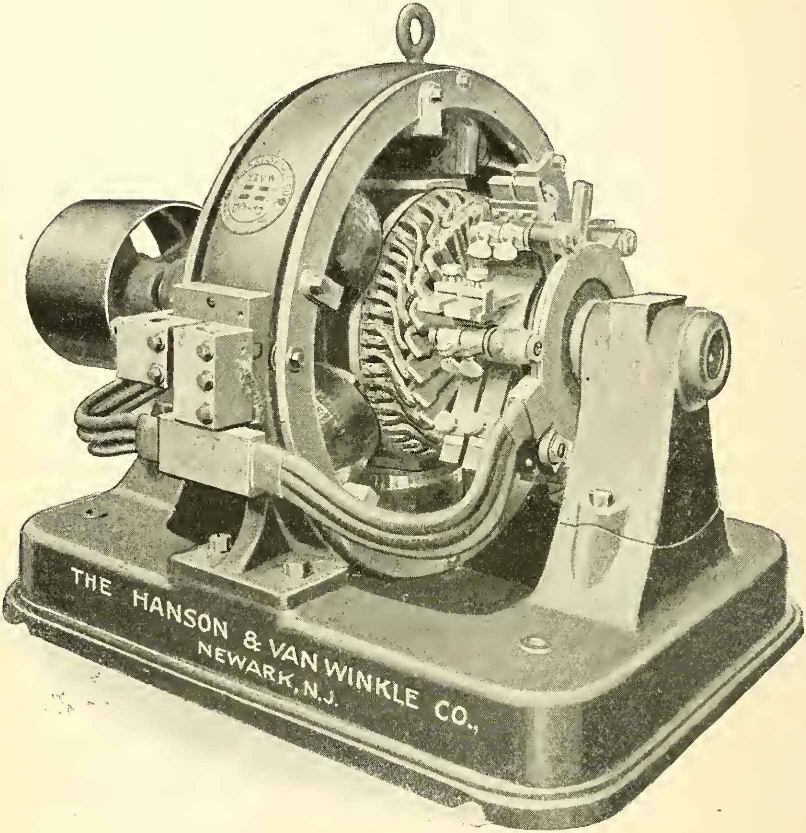

Fig. 43. Multipolar Dynamo showing curved leads from armature windings to commutator, which assist the ventilation.

rent output in a series wound machine, the variation in speed under working conditions gave constant trouble. Putting too much work in the tank decreased the resistance below the designed point in the outer circuit and hence increased the current flow by allowing the machine to run faster with a given amount of power. This was partially obviated by winding to run at lower speeds, but the difficulty was inherent and series winding was finally almost entirely dropped in favor of the shunt wound machines, except where the speed can be accurately controlled, as it was found that it was less apt to burn the work, under average working conditions. The series wound machine would also reverse the current when overloaded, or when the speed is increased 30 to 40 per cent beyond what it should be.

The shunt wound machine has its field windings tapped onto the wires leading from the armature brushes to the tank, with resistance enough in the field windings so that only a desired proportion (from 5 to 25 per cent) of the current will flow through the field windings and back to the other side of the dynamo, while the main portion of the current goes through the tanks. Irregularities of speed do not affect the current in a shunt as much as in the series wound machine, because the amount of current passing around the magnets of the field is less in proportion to the total current generated and it does not vary nearly so much, as the current has another, and generally an easier, outlet through the main circuit and electricity will always take the path of least resistance.

The new machine met with universal favor for some years after its introduction, until it was found that an overloaded machine would drop its current. Of course, the more work there is in the tanks, the more passages there are for the current and the less the resistance will be. When the resistance in the tanks becomes less than that in the field windings no current will flow through them; the magnets will not be energized and we get no current from the machine. This difficulty comes on gradually, so that the first effect is a dropping of voltage and therefore of the quantity of current, which slows the output, and as more work is added to the overloaded tanks the current finally ceases altogether. If platers generally would use ampere and voltmeters, they would know what they were doing and when they had reached the limit of output of the machine they would stop adding work to the tanks and there would

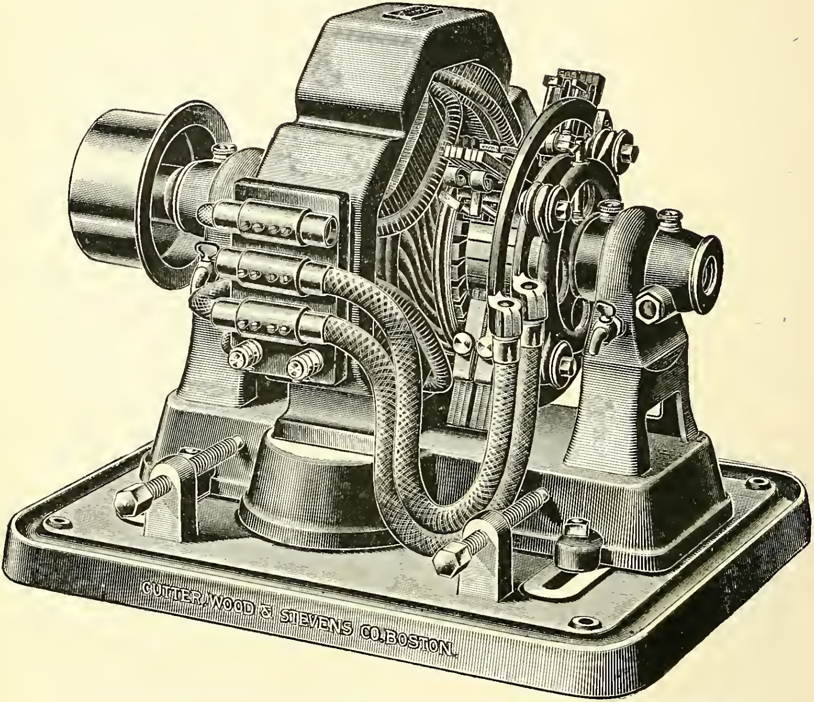
CUTTER, WOOD & STEVENS CO. BOSTON.

Fig. 44. Compound Wound Machine, showing the turns of coarse wire around the field magnets in addition to the shunt coils.

be no difficulty with this form of machine. But as the electrical installation is generally bad and platers insist upon following the guesswork methods which came in with the batteries, trouble is continually present in the plating shop and with the dynamo builder. There are thousands of shunt wound machines now in use; they are still being made and they give perfect satisfaction when they are intelligently handled, but they would not keep up the voltage under an overload and something that would do it was demanded.

This led to the introduction of the compound winding of the field magnets, which is in nearly all of the new machines of the present day, and in which an attempt is made to combine the merits of the series and shunt windings. Briefly stated, it consists of a number of field windings tapped on to each other and all surrounding the field magnets.

The compounding of the field coils of a dynamo consists of both shunt coils as above described and an auxiliary winding of a few turns of the heavier external circuit wire around the outside of the shunt coils. When the load on a compound machine is increased the voltage remains practically constant, as the few turns of the external current passing around the field coils serves to equalize or balance the loss of potential in the shunt coils described above in the shunt wound type of machine. The constant potential of compound wound generator is very essential, as it gives a uniform factor to work within the general scheme of current regulation under varying conditions of load—a

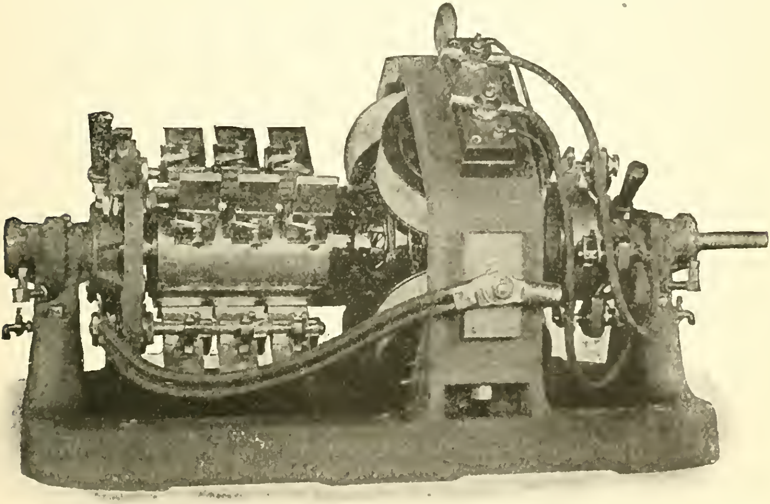

Fig. 45. Motor Generator. The separately excited field is shown by the small wires running from top bar to field coils. The separate motor winding of the armature is fed by the larger wires leading to the small commutator on the right. The tank circuit high in amperes and low in voltage is shown by the large cables leading from the large commutator on the left to the terminals at the side of the field yoke. This machine is motor and dynamo combined.

condition always found in electro-plating establishments.

There is still a third winding of these machines which is known as the separately excited type. In this case the field coils and one set of armature coils are separated from the tank circuit. In another form of this type the magnetic field is excited by a separate current running through the field coils from an independent source of power. The armature slots contain two separate windings, lying side by side in the slots, but not connected in any way. The proportions of the separately excited dynamo windings may be almost anything. The tank circuit consists of a few turns of heavy wire, while the generator or field circuit consists of wire having a definite proportion of the mass of the tank circuit wire—say five per cent of the number of circular mills in the tank circuit wire—and enough turns to make the voltage agree with what is designed for the current through the field. The separately excited field has the advantage that the current cannot be reversed and it can never be dropped; the amount of current in a dynamo depends upon the number of magnetic lines per inch in the field magnets, and as there is no connection between the tank winding and the field winding, overloading the tank circuit will not cause a drop or reversal of magnetism in the field. There is a variation of voltage due to armature reaction, which is caused by the effect of the currents in the two coils in the armature slots lying side by side and being in opposition to each other; but this variation in the machines thus far built and tried is limited to about ten per cent, or eight-tenths of a volt in an eight-volt machine. The idea of having one circuit through the armature and field and a separate circuit through the armature and tanks theoretically offers great attractions; but it has not been tried sufficiently in actual work with very heavy currents, under adverse conditions, and hence no one can yet speak definitely as to what faults it may develop under hard work with large currents in the average shop. As an electric

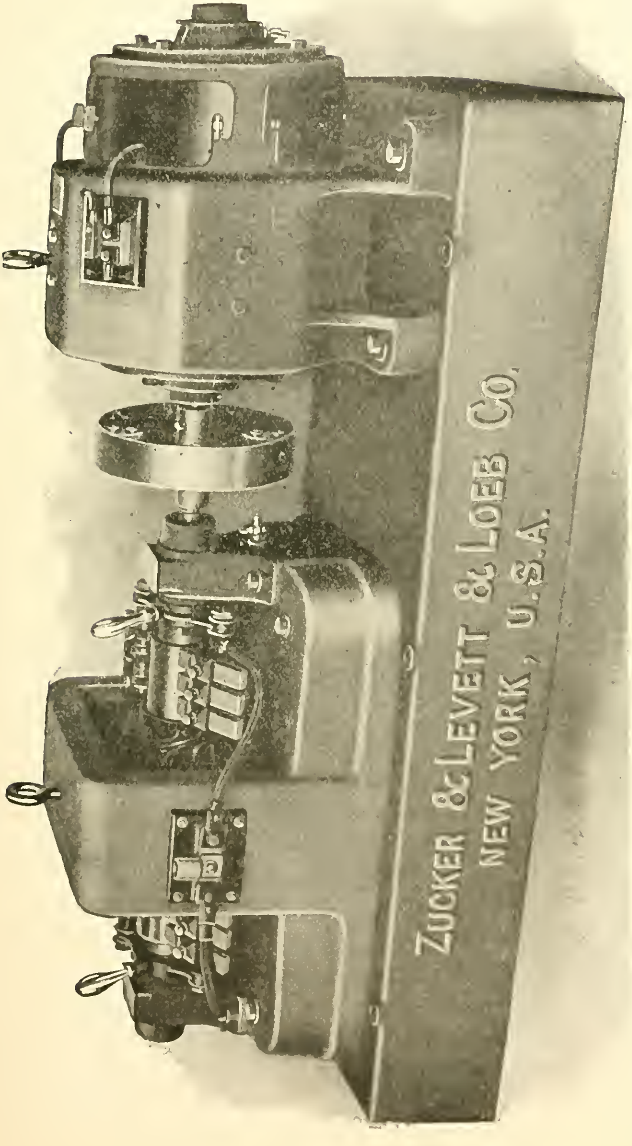
ZUCKER & LEVETT & LOEB CO.
NEW YORK, U.S.A.

Fig. 46. Dynamo and Motor on cast iron base, with field of dynamo separately excited from source of current which drives the motor.

proposition it is attractive, and the small machines which have been built and run experimentally have seemed to warrant in every performance all that has been claimed for them.

The constant extension of electrical distribution of power has created demand for dynamos which shall be electrically driven and we illustrate herewith two types as showing how the plater may solve this difficulty; one has an electric motor mounted on the same base with the ordinary dynamo, the motor shaft being connected with the armature shaft by a clutch or coupling. This coupling should be flexible, so that if the boxes of either motor or generator should wear faster than in those of the other machine and thus let that shaft down at either end, it would not cause friction and binding on the other shaft.

The other illustration shows what is practically a motor and generator in the same machine. In this the field magnets are separately excited from a steady source of power, and this source of power is also tapped for the motor side of the armature winding, a rheostat being placed in the armature circuit to govern the amount of current admitted to the armature winding, and consequently control the speed, as the speed governs the voltage of this machine. The tank side contains heavy wire, wound side by side in the armature slots with the motor winding already described, but has no connection with it farther than the electrical influence caused by the induction of opposing currents in wires, placed near each other, both of which are charged. It therefore has the same armature reaction under overload as previously described in the separately excited generator, but differs from it in having three separate windings; one for the field, one for the motor armature and the other for the tank circuit. The variation due to armature reaction is also said to remain within ten per cent in this machine. Admitting more or less current to the armature circuit will change the speed of the machine and consequently change its voltage, up to the limit for which it is wound. Thus it is possible to obtain anything from one volt to eight volts in a motor-dynamo of this type, which has been wound for eight volts. If the source of supply of the power current is fairly constant, this machine should offer decided advantages. If, however, the current be exceedingly irregular, the speed of the machine is likely to fall off, unless it be watched and the rheostat adjusted. This might be the case if power were taken from a street railway current, for instance, but there would probably be less variation with a steady source of power than now occurs in the ordinary shunt or compound wound machine.

These motor-generators are built to take current at 110, 220 or 500 volts and to deliver a large number of amperes at from five to eight volts. In ordering a machine it is necessary to know the voltage which will be used to drive it. as the machine must be wound for that voltage. Like the separately excited generator, these are new machines, and only the smaller sizes have been built—from fifty amperes up to five hundred amperes. They are giving satisfaction in these sizes when used on electric lighting circuits in city buildings. They have not had extended trial in hard work in large sizes, and hence we cannot speak positively in regard to their performances under adverse working conditions and heavy currents. Still it forms a very useful machine for small work in cities and for shops which have an electric distribution of power.

If the conditions of use have been electrically measured, it is practicable to wind a machine so that it will have a constant voltage under those conditions. This is being done for large establishments which are in charge of electrochemists, but it is manifestly impossible to do it where the electrical conditions are not known beforehand. Having thus briefly sketched the progress in windings for voltage and output we will now glance at some other matters of construction.

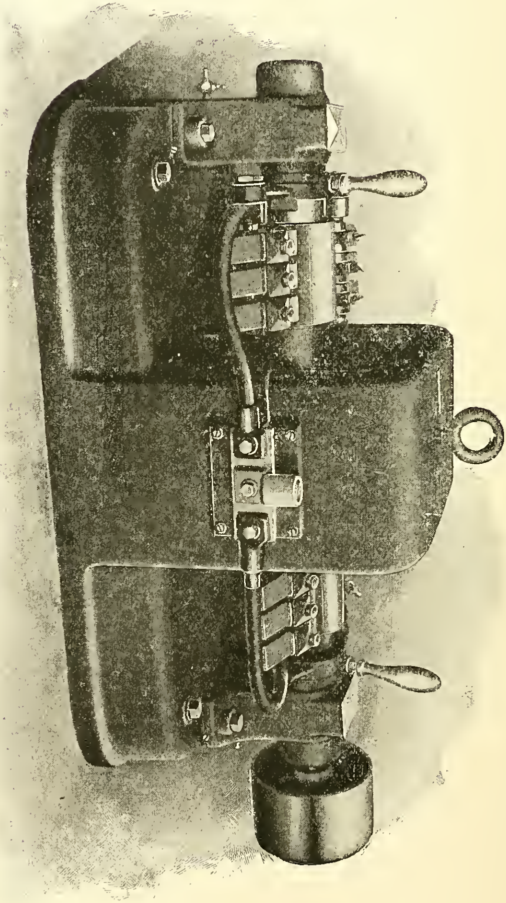

Fig. 47. Bi-polar Dynamo with divided armature, giving balance and more room for the brushes.

The original machines had but two poles and two brushes; this method of construction has continued to the present day in the smaller machines and with some manufacturers in all sizes. When the lighting engineers entered the field for the production of heavy current at high pressure, they objected to this method. They contended that it was better to add more poles and brushes and reduce the speed of driving the armature and commutator, holding that the advantages gained in use more than offset the cost of the extra number of parts; the machine could be made to weigh less and ventilation was better. The advocates of the bipolar type claimed greater efficiency, by avoiding eddy currents and heating, due to the rapid reversal of currents in the armature coils so many times in each revolution of the armature, and greater simplicity in operation by having only two brushes to look after instead of four, eight, sixteen, or even a greater number. The controversy thus begun has never been decisively settled; public opinion has veered first to one and then to the other with each advance in the construction of the various types. The introduction of high speed engines which could be coupled direct to the armature shaft has given a temporary advantage to the advocates of fewer poles, which the recent introduction of steam turbines has still further increased, and they are now in the ascendant in Europe and to a less degree in this country. It is a question of mechanics and of cost of production by the manufacturer, rather than of electricity, and as such need not concern the plater. Either type, as now built, will wear well and do the work he requires of his machine. Many manufacturers of plating dynamos are now building both bipolar and multipolar machines and thus are in position to sell the advocates of either type of machine.

One of the greatest advantages of the modern dynamo is its methods of ventilation. Every mechanic knows that heat can be converted into motion and conversely motion may be changed into useful work or into heat. An instance of the first is the steam engine, in which the energy of heat is transformed into the energy of motion; instances of the second are the machinist's lathe, where this motion is transformed into work and heat at the point of the cutting tool, and in the polishing shop, where the same thing is done with the wheels and buffs. In such cases we do not succeed in transforming our energy of motion entirely into work and what we lose shows up as heat; every polisher knows that the duller his wheels are the more heat he will have on the work.

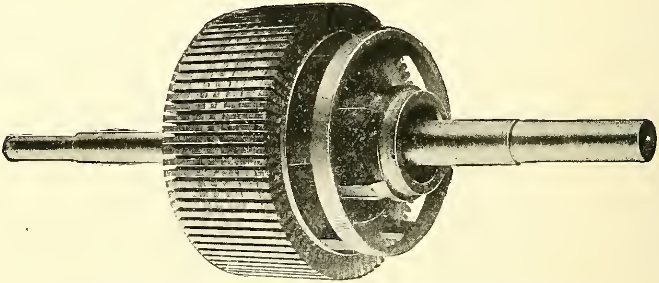

Fig. 48. Modern armature, showing ventilation of the core.

Electricity is a form of energy (like motion) and it will do work or make heat, or do both, just as in the other form of power. There, is, however, the disadvantage that the copper becomes a poorer conductor of electricity with each rise in temperature, so that it is important to keep the copper cool in our armature coils, brushes and field magnets. If we do not keep them cool, then in addition to reduction of current output, we shall finally get things so hot that we will burn up the insulation of our dynamo and thus destroy our machine, so that any means of increasing our ventilation, and thus conducting the heat away from our dynamo as fast as it is formed, becomes highly important, both in current output and in the life of the machine.

The earlier machines had a solid armature core and this was tightly wound with insulated wire; naturally this was easily heated. When hot it took a long time to cool. Every plater who has had to shut down a hot dynamo knows how long it took the old armatures to cool off. The next advance was in making the armature windings in coils, inserted in slots on the circumference of the armature core, and with holes in the core for the passage of air. These ran much better. Then the experiment was tried of making the armature winding of solid rod, leaving it bare and insulating the slot in the armature while retaining the holes. Finally came the practice of using smaller bare wire in the armature slots, held apart by insulation, and with the leads to the commutator sections curved so that when the armature revolves they act like blades of fans and force a constant stream of air through the armature. This is plainly seen in the illustrations of modern dynamos shown in these pages. Such machines will run slightly beyond their rated capacity with a very small increase of temperature above that of the surrounding air, provided the work is not increased in the tanks to take up the extra volume of amperes which this speed will produce; in this case the effect is a rise in voltage; and any of them should run in ordinary working conditions 50 degrees F. above that of the room.

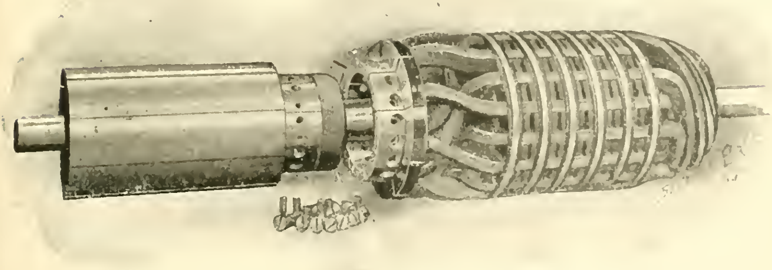

Fig. 49. Modern armature winding, showing ventilation and method of attaching to commutator.

The above has been set forth in detail because of the troubles constantly encountered in plating shops, which are due solely to ignorance on this point. Many platers think that the dynamo is their most expensive machine and it deserves great care, so they build an airtight box around it to keep the dust away. Under such circumstances the dynamo, being 50 degrees hotter than the surrounding air, soon raises the temperature of the air; and this process is continuous until trouble arises. The writer was once sent 185 miles into the country to see what was the matter with a new dynamo of latest type. When he got there he found the dynamo closely covered with a nice hardwood box and so hot it made severe burns on his hands when he touched it in taking off the box. He chopped that box into little pieces and carried the pieces into the boiler room while he said things to the plater. Then he took the next train for the city, and there was no more trouble with the machine. Others have made a nice little room for the dynamo, papered the walls to make them dust proof, and painted the floor. This, while it is not so bad because it is larger, is a detriment to the machine. A dynamo generates heat constantly and must stand where the heat can be carried off. A room that is not too dirty for plating solutions will not be too dirty for the dynamo, and far more damage will result from boxing it than will result from the dust.

A modern dynamo will give a far greater capacity for a given weight than the older machine and less power is required to drive it. It sparks less and consequently does not rough up the commutator nearly so often. Many of the older machines required frequent adjustment of the brushes as the work varied in the tanks. This was often not noticed in the job shops, where the work was small, but was disagreeably evident in shops where the pieces of work being plated were of considerable surface, so that a few being put in or taken out would alter the load on the machine very perceptibly.

The old machines had the armature wires soldered to the commutator bars, making them difficult to repair, while the new ones allow the commutator and the various sections of the armature windings to be taken out and replaced without difficulty.

Another important point is the difference in ratings. The old machines were rated at nearly their greatest capacity and many a plater who bought a 1,000 ampere machine found his voltage beginning to drop when the machine was giving 600 amperes, or even less. The new machines are rated lower, so that the full number of amperes of the given voltage may be obtained from them. This is an important point to remember, if you are tempted to buy a machine of old type. If it is in good order it will probably stand up under 50 to 70 per cent of the output for which it was originally sold.

There was no dishonesty in the original ratings, simply a misunderstanding of the needs of the situation. The manufacturers had not then discovered the tendency of the platers to buy about 300 amperes less capacity than they really needed and then overwork the machine. The platers did not (and many of them do not to-day) have any idea as to how much current they can use profitably, so they bought the smallest machines that could be made to run their work at the average output of the shop. In busy times it was not enough and the machine was generally overworked during those periods; if the business was increased the overwork was continuous.

Another factor which led to the general use of machines which were too small was that, owing to the absence of ampere meters in plating shops, no reliable data exists, even to-day, as to the quantity of current which is necessary on certain classes of work. Tables of amperes per square foot of surface exist, of course; they may be found in any catalogue of any supply house; but these tables are wholly misleading. They were made by taking, for convenience, thin sheets of metal and measuring the number of amperes per square foot which could be used to deposit metal on the sheets without burning. They are correct as applied to that sheet; but the mistake was made of supposing that only the surface need be considered. For instance, the tables state that cyanide of copper solutions require six to eight amperes per square foot; acid copper, ten to twelve amperes. This is true on a sheet of twenty-two gauge, but a plate a half inch thick will take twenty to twenty-seven amperes, and a cast iron panel three-quarters of an inch thick and four by seven feet in its other dimensions will require from fifty to sixty amperes per square foot to put the metal on properly in the center without burning at the corners. Twenty amperes per foot is common practice on heayv work where six are indicated in the tables, and nickel plating direct on sheet zinc will take sixty amperes per foot. Of course a dynamo bought according to the tables will be wholly inadequate for anything but thin sheet metal.

It is easy to see how the mistake arose. The limit of quantity of current is at that point at which the metal commences to discolor from the heat evolved when the metal is deposited out of the solution; a thin plate conducts heat slowly beyond a given quantity. On the other hand a large, heavy piece contains metal enough to conduct the heat away as fast as it is formed and ten or twelve times as much current may be used profitably on such work. Between this and the thin sheet there are numberless gradations of work which have never been properly measured by anybody.

When the use of ampere meters becomes general in plating shops we shall, doubtless, have a series of observations of the quantities of current needed on certain classes of work. These will eventually be collected and tabulated and then we shall have more reliable data on which to purchase our dynamos intelligently. At present this knowledge is possessed only in fragmentary form and by only a few dynamo salesmen. If they offer it to anybody who is considering the purchase of a machine, they are not believed because the information given is so greatly at variance with what has hitherto been published. If some of the professors in the electrochemical departments of our universities, or polytechnic schools, would, from actual experiments, prepare a new series of tables which would consider mass and heat-conducting capacity of the cathodes, as well as the surface, they would perform a much-needed service for a large and constantly growing industry. At present not one plater in a thousand knows how much current he can use profitably on various classes of work. If, by accident, he meets a salesman who does know, the number of amperes he mentions is so great that the plater concludes the salesman knows nothing and is trying to sell him a much larger machine than he needs; so he compromises on a smaller one than is recommended, but which is larger than he intended to get, and the improved machine is so much better than his old one that the plater really believes it completely meets all demands of the situation. In two or three years this is repeated; and so we will go on guessing, until complete data, made from actual work in the shops, shall be available.

It would prove very annoying and expensive to have to put in a larger dynamo every time you wished to add a few gallons of solution or a few hundred gallons; so it is wise to get a dynamo with a capacity for handling much more solution than is required at the time of purchase. The plant may then be enlarged at will. Besides a larger and more powerful machine than is actually required will do the work much more satisfactorily in every way, as it will be run at a lower speed than a machine just capable of handling the work would require, and thus cause the least possible strain on the working parts, such as bearings, commutators and brushes, and greatly prolong the life of the machine.

The dynamo should not spark, and the modern machine is very nearly perfect in this respect, if properly handled and kept clean, but it requires just enough handling to keep it clean and properly adjusted—no more. If just sufficient for the work at hand and worked to its fullest capacity, the machine is very apt to heat and spark badly and at times requires to be shut down and allowed to cool off to prevent it from burning out when the vats are full of work, thereby causing much delay and requiring much extra labor and annoyance in doing over work which may have been in the tanks and only partly plated when the shut-down occurred. This cannot always be laid to the dynamo, for the best machines will heat and perhaps burn out if overloaded.

The small-sized dynamos are more apt to spark than the larger ones and require more attention to keep them running properly. It is a mistake to follow too closely the printed directions that accompany the machine as to setting up and adjusting, as these must in their nature be general, and do not always conform to special conditions, which may be present in the shop. Of course, the beginner, if he has no previous knowledge of dynamos and electricity, must adhere to the directions until he becomes acquainted with his machine and its requirements; he will soon learn, however, under what conditions of adjustment it will give the best results. The experienced plater knows just where and how he wants the dynamo for any particular plant.

Dynamos should be so constructed that the operator can get at the brushes and all set screws and their adjusting arrangements quickly. All thumb screws should be corrugated or knurled, and the adjusting lever on the side rocker arm, which is used for swinging the brushes around the commutator to different positions, should also be corrugated. This is a point sometimes lost sight of by manufacturers, but it is very annoying to the plater to try to adjust his dynamo in a hurry with all the thumb screws of the adjustments smooth. When his hands are either wet, or soft and tender from being in the water, he is unable to turn the screws without the aid of pliers, whereas the corrugated ones may be adjusted easily.

The dynamos should usually be placed at one end of the row of plating tanks, or as near to the main body of solution as possible, as long stretches of conducting copper tend to reduce the current. If the rows of tanks are very long the dynamo should be connected at the center of distribution. I have seen as high as thirty tanks in one row. It should be set three or four feet from the floor, so as to avoid dirt when sweeping, and should rest upon a perfectly rigid foundation, which will greatly assist the dynamo in maintaining a steady flow of current, and prolong its life. Owing to the sharp competition in the manufacture of dynamos, they have become well-nigh perfect in point of construction. The bearings should be self-oiling. The brushes should be provided with springs that will give them flexibility and allow them to rest firmly, yet not rigidly, upon the commutator. The armature should be large and wound to insure low speed in the machine. The windings of the armature should be imbedded in slots in the circumference of the armature and the metal in the core be allowed to project a trifle above the wire of the windings in such a way that the insulation of the wire will be protected from coming in contact with the field magnets. The journals sometimes become worn without being perceived by the plater, letting the armature slightly out of place, and as it runs very close to the field magnets it is likely to rub or strike them, thus destroying the insulation on the armature and causing a loss of current, and heating of the machine. If the insulated wires are well protected the difficulty may be located and remedied before any damage results.

Those not accustomed to handling electro-plating dynamos have the idea that they are constructed just as lighting machines or motors are, and therefore must be as dangerous and liable to shock those touching them. This is a wrong impression, as the plating dynamo is so constructed that it is next to impossible to receive a shock from it that would be harmful. Still, there are conditions under which quite a painful shock may be obtained; for instance, when the commutator of the machine becomes burned into ridges or furrows along the segments, causing a vibration in the brushes as the current is carried off and also making waves and impulses in the current, which will cause shock.

The plating machine should be placed where it will get good ventilation and yet be free from dust and dirt, and where light enough may be obtained to adjust it intelligently. If it can be placed near an open window, without inconvenience, this would be an advantage. The dynamos should never, under any circumstances, be placed in the polishing or buffing room, as particles of emery and metal from the wheels will lodge on the commutator or in the brushes, causing cutting and sparking in spite of all you can do to avoid it. The lint from buffs will also get into the brushes and cause sparking and burning.

One person should have entire charge of the dynamo, and it should be cleaned every morning, but nothing more should be done if it is running smoothly. Some machines will run for days and even weeks with a steady current and no sparking when the work is running evenly in the shop. So it is best not to tamper with it when running perfectly, or nearly so, as you may often cause the condition you wish to avoid, that of sparking and cutting. It often happens that a machine may be working beautifully and giving uniform results for weeks without any adjustment whatever, when you will be suddenly surprised to find you have no current and can get none. The difficulty will very likely be found in the commutator becoming glazed over too thickly with oil, preventing proper contact between the brushes and the insulated segments of the commutator, thus destroying the current. The current may also be destroyed by a short circuit, caused by a piece of metal of any kind coming in contact with both conducting rods of the dynamo at the same time.

In cleaning the commutator, never use emery in any form, as it will imbed itself in the copper and cut the brushes, causing sparking and loss of current. Use very fine sandpaper, put around a flat stick, which will tend to keep it flat and even. The brushes should be lifted from the commutator, or removed, while the sand paper is being used.

Brushes are generally bevelled to fit the surface of the commutator and they should be kept so by filing with a smooth half-round file. The brushes should also be removed when they become covered with oil and have the oil and grease removed from them by cleaning with gasoline or benzine. When adjusting the machine have the brushes properly bevelled, so that they will come in contact with the commutator the full width of the brush and not touch it only in the center or at one corner. Set them so they have an even, gentle pressure upon the commutator. The brushes must not be set rigidly, but have a flexible, springy position, the commutator being first smoothed and slightly oiled with a piece of hard felt which has absorbed oil and plumbago and is then held lightly upon the commutator. Very little oil is sufficient and it should never be applied directly to the commutator in liquid form. When the commutator is clean and smooth after being slightly oiled, the machine should be stopped and the brushes put in position as just described, with particular care that one set is diametrically opposite to the other, and to secure an even contact on the commutator and an even and gentle pressure on all brushes alike. When this is done the machine may be started, and if it sparks move the rocker arm by the lever attached to it around the circle of the commutator until sparking ceases. If the brushes are evenly and properly adjusted there will be little difficulty in finding the non-sparking point. If you still have sparking, the trouble is perhaps with the brushes, which should be readjusted while the machine is running until the trouble is controlled. Dynamos may be adjusted while in use without dropping the current, especially the large four and six-brush types.

Purchasers of dynamos very often find the machine not able to accomplish the amount of work claimed for it by its manufacturers. The machines are guaranteed to accomplish a certain amount of work, or deposit a given number of ounces of metal in a certain time, or a shell of metal a given thickness in a certain time under certain conditions, but usually one or more of these conditions are lost sight of or altered in setting up the machine; then the trouble begins. Usually a machine set up and run, just as it should be and according to directions, will do much more work than is claimed for it.

In "wiring" from the dynamo may be located a frequent cause of trouble with the dynamo in the past and even to some extent in the present practice of many platers. In the past it arose from the frequent inability of the plater to understand, or an unwillingness financially to recognize, the fact that the conducting power of a wire, rod or cable is exactly proportioned to the amount of metal contained in it and to the conducting power of that metal; also to its capacity for radiating heat to the surrounding air. In the present the error of having too small conductors arises from the misunderstanding as to the quantity of current which is really used on various classes of work and to the use of tables for computing current which take account of the surface only, as previously referred to at length when speaking of the purchase of dynamos. The wiring must, of course, be done before plating can commence; hence it is done by calculation, from the tables referred to, as to the amount of current that will be used in the tanks; or by guessing from previous experience. In either case the wiring is faulty. It may be calculated so as to give good service when all the tanks are full of work and the current is distributed among them in proper proportions. This ideal working condition is, however, seldom maintained very long at a time in the average shop. It is more frequently the case that all or most of the work is being done in one or two tanks, with little or nothing in the others. Then the taps, or branch wires, to those tanks become too small to allow the current to pass in sufficient quantity without heating, and trouble commences. The resistance of the wire increases rapidly with the heat; soon the whole system gets hot and heating then commences in the dynamo. The time required in doing the work is more than it should be and the cost is increased so that the plater may make a loss when he figured on a nice profit. This is frequently the explanation of why one plater can do work cheaper than another. All the wiring should be large enough so that a very large amount of current may be thrown into all tanks at once, or into any one tank, without heating the conductors.

The connections found in all plating supply catalogues, and hence in all plating shops, are another cause of trouble. They are a survival from the dark ages of plating—the battery ages—and have caused more trouble, cost more money, and reduced the output more in the average shop, than all other sources of loss combined. They lasted less than six months in the lighting field, because the electrical engineers had measuring instruments with which to locate trouble. The platers, however, guessed at things, so the old battery connections, designed to carry one or two—maybe ten—amperes without heating are still in use on dynamo circuits, and so hot that if you touch them you burn your fingers. As originally designed, they were drilled in sizes of holes which would tightly fit the sizes of wire and the set-screw merely prevented the wire from being pulled out of the hole; the current passed from the wire through its entire circumference, which fitted the hole closely. There was metal enough, and enough surface in contact, to pass the current without heating, as all currents were small. When they were used on dynamo circuits the case was altered. The main conductor rods were rolled up, or bent into convenient lengths, for shipping. These were roughly straightened on the floor of the plating shop, leaving numerous bends and kinks in them. The connections had to be slipped on the rods from one end and a hole of proper size would not pass these bends in the rod, so larger holes were substituted. Then the current could only pass through that portion of the surface in the hole which was tangent to the circumference of the conductor bar and through the point of the set-screw. This reduced the amount of surface in contact to from one-sixty-fourth to one-hundredth of what it should be and heating commenced. The greater difference there is in the sizes of rod and hole, the less will be the surface in contact and the poorer the connection. The electrical engineers, being provided with measuring instruments, found this out immediately and discarded the connection. The platers have continued its use, and we generally see a No. 3 wire in a 0000 hole. The connection should fit closely the entire circumference of the conductor and should have metal enough in it to carry the current without heating.

Figs. 50 to 54 show the form of connection used in electrical engineering with currents that are high enough in voltage to cause trouble from poor contacts. Any plater can get them made at any machine shop. They consist of halves, with ears, drilled to receive stove bolts, by which they are clamped tightly upon the wire. They are cast from copper or low brass, clamped together with thin washers between the ears to hold them apart slightly and then drilled to fit the wires exactly. After being drilled the washers are removed and the boxes may then be clamped tightly on the conductor rods and wires so as to fit perfectly. They may be put on or taken off with a small wrench and screw driver and are much more convenient when making changes, as they do not require the stripping of the main conductor in order to get a new connection on where it is wanted.

With the use of the unions, elbows and tees, a plant may be easily and rapidly wired with a hack saw to cut the rods, a file to smooth the ends, and a wrench and screw driver for the stove bolts.

In making the patterns for the castings, they should be made so that the annular space left after boring out will have metal enough to equal the metal in the conductor on which they are used. Thus a one-inch round rod has an area of .8627; this amount will be bored out and we must have an equal amount left; twice .8627=1.7254 area, or a diameter of one and three-eighths inches for our pattern, so that the metal left to bridge the gap of our union or elbow will be equal to the metal in the conductor.

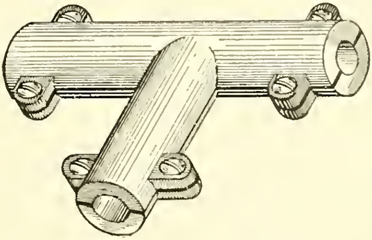

Fig. 50. Split T; a superior connection for running branch wires from main conductors to tanks. The upper hole is drilled to exactly fit the main, while the lower fits the tap wire to tank. Can be put on and taken off by unscrewing the stove bolts, without disturbing other parts of the electrical system.

Figs. 53 and 54 show what is known among engineers as a "terminal." It consists of an eye, either made separately and attached to the end of a rod or wire, or it may be made by flattening the end, punching a hole in it and rounding the edges. The latter is more work, but is preferable, as there is then no joint in the wire. These terminals should be placed on the ends of all tank rods and also on the lower ends of all tap wires running from the main circuit to the tanks. We then have large flat surfaces which may be bolted together so as to insure good contact and also a connection which is easily made or broken when we wish to take the rods off for cleaning. The flat surface of the contact makes it very easily cleaned and the bolted connection is much easier and more secure than those now in use. Any small bolt and nut may be used with them.

It is safe to say that the substitution of these connections will speed up the output and cool down the dynamo to a surprising extent in the average shop and no plater will ever regret the time and trouble spent in making the change.

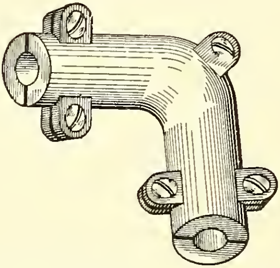

Fig. 51. Split Elbow for use in making electrical connections where a quarter turn is desired, as in the corner of a room. etc.

Figs. 55 to 59 are various forms of insulated wire holders, for use in running wires about the shop; they consist of metal clamps containing porcelain holders which are in halves and so constructed that they may be opened and the wire put in or taken out easily. They are quickly put in place and easily removed and range in sizes of quarters of an inch up to two inches diameter of the circular hole. They may be bought of any electrical supply house and are very cheap and efficient. It has been customary to run wires from a plating dynamo any old way and grounding has frequently caused trouble which these fixtures will prevent.

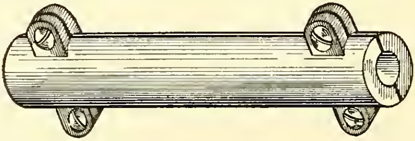

Fig. 52. Split Union for connecting conductor rods, etc.

Insurance companies are getting more strict and many of them now require that any bare wire carrying electricity shall be suitably insulated. These insulators will comply with such demands.

As to the sizes of the tap wires needed to carry current from the main conductor rods, little is really known, except that they are generally too small. The man who sells and installs a dynamo will get his main leads big enough if the plater will let him. But the poor connections, the lack of measuring instruments, and the absence of reliable data as to the amount of current which may be used profitably on various classes of work, have prevented the laying out of wires from the mains to the tank rods in such a way as to be sure of their electrical efficiency at such times as the work being plated is heavy and confined to a few tanks, while the others are idle. Any plater can see that if his work can use thirty amperes per square foot, when the tables say six, the wires from his mains to the tank rods must be capable of carrying that amount of electricity or he will not get it in his tanks.

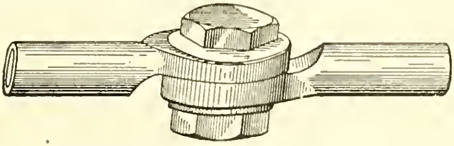

Fig. 53. Terminal made by flattening and boring the ends of tank rods tap wires, etc., showing the method of bolting to make a good connection which is easily cleaned

An area equal to one square inch is required to carry 1,000 amperes. A copper rod one inch by one inch, or a strip of copper four inches by one-fourth inch, or two inches by one-half inch, will fill this requirement. If round wire is used, an area equal to one square inch must be employed, or a conductor about one and one-eighth inch in diameter.

The above specifications apply only to installations where the distance from the dynamo to tank—measuring along the entire length of the conducting wire—is not more than 40 feet. For distances greater than 40 feet the size of the conductor should be increased as the distance is increased. Double the size conductor is needed for a line connection of 80 feet, while 50 per cent increase in size of conductor is required if the distance is increased 50 per cent over 40 feet. This is at variance with the tables compiled for currents of 100 volts and over, but is true with low voltage such as is used in the plating room, the reason being that the pressure here is so low that any slight resistance will destroy it.

In arranging branch wires from main line to tanks, it is necessary that the wires be large enough to carry, without heating, enough amperes to plate the full load of the tank. The capacity of the tanks in square feet of work surface can be readily determined; then with a knowledge of the amperes required to plate a square foot of surface of the various metals, the total amount of amperes needed for the full number of tanks and the size of wire best adapted to carry the current can be determined.

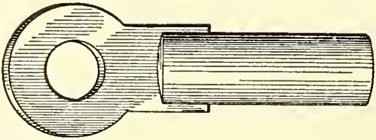

Fig. 54. Terminal with eye inserted for bolting up tank rods, etc. The flat surface gives a connection that is easily cleaned and the bolts allow it to be easily made or broken. See Fig. 53.

For the convenience of platers we give below a table showing the number of volts and amperes required to deposit a square foot of surface of each of the various metals, according to the size articles to be plated and the density of the solution, and the carrying capacity of the different sizes of copper wire.

AMPERES REQUIRED TO PLATE ONE SQUARE FOOT UPON THIN METAL.

	Volts.	Amperes.
Nickel	2 —5	4
Nickel on Zinc	5 —8	60 or 70
Brass	5 —8	6 or 8
Bronze	1½—5	6 or 8
Copper Cyanide	1½—5	6 or 8
Copper Acid	1 —3½	10 or 12
Silver	½—4	2
Gold	¼—4	1½
Zinc	5 —8	10

If the work is heavy enough to conduct heat rapidly the number of amperes may be multiplied by from six to ten, as the quantity of current is greater than here indicated.

CARRYING CAPACITY OF COPPER WIRE.

	Amperes.
No. 3 B. & S. Gauge	50
No. 0 B. & S. Gauge	100
No. 0000 B. & S. Gauge	180
½ inch Diameter	225
⅝ inch Diameter	350
¾ inch Diameter	500
⅞ inch Diameter	650
1 inch Diameter	750
1⅛ inch Diameter	1,000

In computing the surface of work in the tank all surface which the solution touches must be counted, whether it plates or not, as current will pass to it, even if it does not plate. This has been tested repeatedly with hollow objects and found to be true; by first measuring the current with the solution excluded from the inside and then measuring again with the solution admitted freely to the interior.

Having figured the surface of the work by the above tables for the surface of the various solutions, and made the necessary increase in the figures to allow for plenty of current on the heaviest work you are likely to do, you can select your wires to carry current from the mains to the tank rods by using the table of carrying capacities, and it is safe to say that the results will surprise most of the old platers.

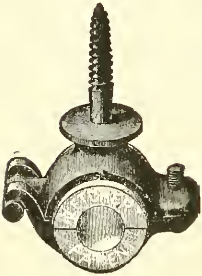

Fig. 56.

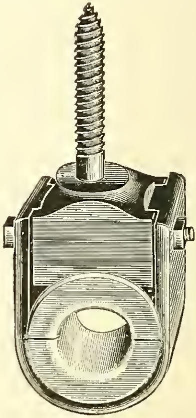

Fig. 55.

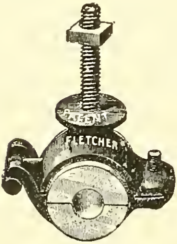

Fig. 57.

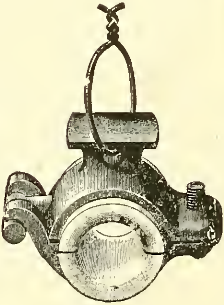

Fig. 58.

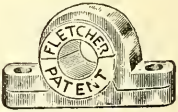

Fig. 59.

The tank rods are also a source of trouble in some establishments and would be found to be insufficient in many others if insufficient mains and tap wires did not cut down the current before it reached them. Some platers—happily these are few—will attempt to use iron gas pipes for tank rods. The conductivity of iron is much less than that of copper or brass and the amount of metal in them would have to be two or three times that of the copper tap wires leading to them. Iron is easily corroded and its exposure to the moisture and corrosive liquids and gases of the solutions makes it practically impossible to keep it clean enough to make good contact with the anode hooks and wires used in suspending the work, so that there is a great loss of current where iron rods are used.

Iron anode rods are sometimes used on silver solutions. In this case a piece of three-quarter or one-half inch round iron rod is bent to the shape and size of the inside of the tub and is hung into the tub by iron hooks suspended over the edge, allowing the anode rod to hang just under the surface of the solution. Being under the surface will keep the iron rod clean and it is not affected (noticeably) by the current, as this is of low voltage. The silver anodes are then attached to iron wires with the end of the wire projecting above the loop and out of the solution, so that the anodes may be removed and replaced without getting the hands into the solution. One end of the iron rod should project upward to the top of the tub to receive the electrical connection from the main or tap wire.

Brass tubing of light section is sometimes used, reinforced by iron pipe stuck inside to stiffen it. This is not so bad as the use of the bare iron, as it does not corrode so easily, but is generally lacking in proper conductivity and is bad practice on that account.

Brass tubing of heavy section is also used with and without iron rods or tubes to strengthen it. If properly figured, so that the amount of metal in the wall of the tube is sufficient to carry the current, they are very good when new and clean, but if used on cyanide or acid baths where the solution is constantly being dripped on them when taking work out of the tank, the zinc in the brass will soon be eaten away by the potash, cyanide and acid, and such rods soon become honey-combed to such an extent that their conductivity is reduced and their strength impaired.

Copper tubing is much better than brass, especially if it be of sufficient thickness to conduct the current and is properly strengthened with close-fitting iron pipe or rod. Do not understand "thickness" as used above, to mean diameter of the pipe; by thickness we mean thickness of the wall of the pipe—not its diameter. The amount of metal in such a pipe is determined by multiplying the square of the outside diameter of the pipe by .7854; doing the same thing with the inside diameter and subtracting one from the other to get the area of metal contained in the annular wall of the pipe. This area of metal in the wall should never be less than the area of the tap wires carrying current to the rod, as if it is less it will choke the current and cause loss by heating. If compelled to use copper tube that is too thin, the diameter of the pipe should be increased until the amount of metal in the pipe is a little more than that in the tap wire.

Copper rods make far the best tank rods and should be used whenever it is possible to obtain them. They are the most durable, most easily cleaned and have the longest life. If they get badly corroded through neglect or carelessness they may be sent to the polishing room and buffed up and there is metal enough in them to give the proper conductivity if they are stiff enough to properly support the work.

The ends of tank rods should be formed into terminal eyes, so that they may be connected to the tap wires by a bolt and nut, as shown in Fig. 53, as this forms the simplest and most durable connection for the purpose, particularly in shops where it is desirable to frequently remove the rods from the tanks for cleaning or other purposes.

It has been customary in many shops to merely place the rods across the edge of the tank, allowing them to remain in position by their own weight. Others have nailed a strip of soft wood across the ends of the tank on which to rest the rods. When this strip becomes wet from rod to rod, as it frequently does in handling work, where tanks are close together, a short circuit is established through the strip of wood soaked with solution, a portion of the current is cut off from the tank and the dynamo must be worked that much harder to furnish sufficient current to the work in the tanks. If the strip has been used a number of years it will generally be found to contain sufficient metallic salts and metal to form a conductor when dry, as well as when wet.

A simple method of insulation may be practiced by thoroughly japanning or varnishing these strips before putting them on and then keeping them clean and dry. Another method is to use rubber—generally a piece of belting or hose—under each rod, with due attention to cleanliness. A better way is to use insulators of porcelain, see Figs. 56 and 59. They are cheap and effective, hold the rods firmly in place and allow them to be easily removed, either by opening the insulators and lifting out the rods or pulling them out lengthwise if there is room. In this way the rods are held up, free from the tanks and drippings from the solution cannot cause short circuits. There are more short circuits on tanks than most platers realize as an amperemeter will show if one is in circuit.

Too much care cannot be used in keeping up a constant inspection of the electrical wiring. Nothing should ever be permitted to touch the conductors, and the practice prevalent in many shops of allowing the men to hang wires and other things on the conductors cannot be too strongly condemned. This is especially true where the conductors pass near gas, water or steam pipes. Even with due care exercised in these inspections short circuits are constantly occurring and one of the first things to do when trouble with the dynamo occurs is to look for short circuits. Many a plater has sent to his supply house for assistance with the dynamo and had the salesman sent to look after the matter come in and take away a bar of metal, a file, or other tool which was lying across the conductors or touching a conductor and a gas pipe. It would seem that a plater ought to know enough to find these things himself, but he gets confused and asks for assistance when the trouble is plain to the first man who enters the room. Sometimes these grounds are more difficult to detect. An expert connected with a large eastern house gives the following instance: "The writer witnessed a test for amperes on a one hundred gallon vat of copper solution, the copper solution being in an iron vat connected by steam pipes to various parts of the shop. At five volts, with the solution at 130° F., two square feet of work took 320 amperes while an additional two square feet took fifteen amperes extra, making 335 amperes for four square feet, or 320 amperes for the first two square feet. This test was made several times with a Weston instrument and we were forced to accept it as true, although all theories were upset by the results. We then commenced a search and found that the iron tank was grounded to the steam pipes and also through the earth. This will account for a great many overloaded dynamos."

A habitual inspection of the circuit, whether anything seems to be wrong or not, will result in saving many times the trouble it takes to do it daily. A plating shop is constantly changing its employes, and while the older men may have been trained to let the wires alone, a new man is likely to cause a short circuit the first time it is more convenient to lay something across the conductor than to put it away.

Hooks for all anodes, except silver, are usually made of copper wire. All these hooks, rods, connecting wires and connections, in the well-regulated shops, are kept bright and clean. The rods are rubbed with sandpaper or with a wet rag and powdered pumice stone. The anode hooks and connections may be dipped in the bright acid dip, rinsed hot and dried. A boy can do this work and if it is attended to every morning before beginning plating there will be no delays from bad connections as the rods will be always bright and clean.

Some platers have a general cleaning and fixing up day. This is poor practice, as it requires a lot of disagreeable work to get badly corroded rods into a satisfactory condition. When a rod has been allowed to get badly corroded, so that it cannot be cleaned by ordinary methods it should be sent to the polishing room and cut down on a canvas wheel, with 120 emery.

CHAPTER VII.

ELECTRICAL MEASURING INSTRUMENTS FOR THE PLATING ROOM.

So much has been said as to the use of measuring instruments in handling current in the plating room, and the use of such instruments among platers is still so limited, that it seems advisable to set forth plainly and simply just what a measuring instrument is, how it operates and how it is installed and used. While this explanation may be unnecessary to a large number of platers, still this work is liable to fall into the hands of many beginners and the insertion of this matter seems therefore advisable.

First we will explain the terms used in handling electricity, as we shall find them on the dials of our instruments. Like other forms of energy, electricity varies in its amount, or quantity, its potential or the amount of energy contained in a given quantity, and is subject to frictional losses in transmission. This requires, therefore, three measurements in order to properly understand the amount of energy available for work at any given point. In this respect it bears a close resemblance to steam, in that it requires special apparatus for its transmission, is subject to frictional losses, to leakage if the system of transmission be faulty, and varies in the amount of energy transmitted in a given time, according to the initial pressure given it when starting upon its journey. As very much more energy is transmitted through a steam pipe with the steam at 200 pounds pressure than with the steam at 10 pounds, so more electrical energy is transmitted through a wire at 200 volts than at 10 volts.

Both are subject to loss of pressure through friction and heating of the conductor if the size of that conductor be insufficient for the work it is called upon to perform. Thus we see that the analogy is close. Like every other standard of measurement, the electrical standards were arbitrarily selected and adopted by common consent. They are the ohm, volt and ampere.

The ohm is the unit of resistance, or frictional measure. It is very nearly equal to the resistance of pure copper wire, 250 feet in length and one-twentieth of an inch in diameter.

The volt is the unit of pressure. It is such a pressure as will pass one ampere of current through one ohm in one second.

The ampere is that quantity of current which will pass through one ohm in one second at one volt pressure.

The various standards can be purchased or devised in various ways, so that they can be used in making and marking the dials of commercial measuring instruments, and as the subject of electrical measurement is so vast and there is so much literature on the subject which is readily obtainable by those who desire to go into it at length, it is unnecessary for us to treat it further here.

The mechanical generation of electricity depends upon the fact that current is generated by passing a copper wire across the lines of magnetic force proceeding from the poles of a magnet. This is our dynamo. We have also the further fact that copper wire wrapped around a piece of soft iron will render it magnetic when current passes through the wire. This being the case, if we take a magnet, fix soft iron so that it can revolve between the pole and wind it with wire, we shall have two magnets (one between the poles of the other), whenever current passes. As like poles repel each other, we now pass the current through the wire in such a way as to make the soft iron poles have the same magnetic polarity as the poles nearest them in the permanent magnet, when the soft iron magnet will tend to move away from the other. The extent of its motion will depend upon the strength of its magnetism and if we attach a pointer to the axis on which the magnet is suspended and place a scale under the outer end of the pointer, we can by the use of our standards graduate the scale so that the pointer will indicate the pressure or intensity of the current flowing in the wire surrounding the soft iron suspended magnet. All the older instruments were thus constructed but later it was found that the helix of wire contained magnetic lines enough to dispense with the iron core and they are now made in that way.

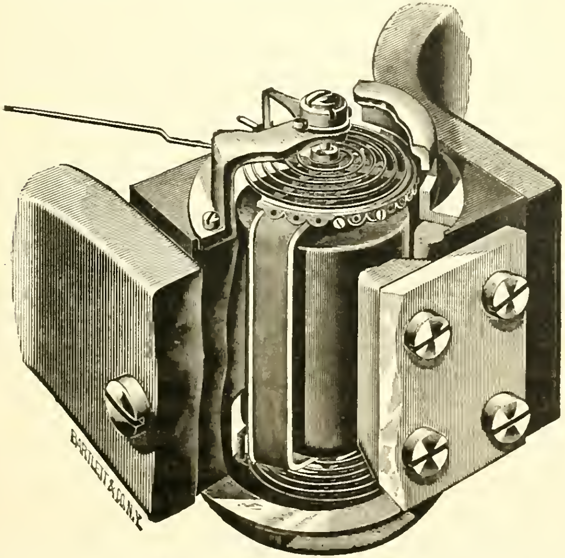

Fig. 60. View showing construction of Weston Voltmeters and Ammeters.

Fig. 60 illustrates the working portion of such a measuring instrument without its case. It can be proportioned and the scale graduated to indicate pressure in volts, in which case it is called a voltmeter; or it can be made to indicate quantity and it is then called an amperemeter, or ammeter.

In the illustration we see the two ends of a large, heavy permanent magnet, the poles of the magnet being curved and one of them cut away in order to show the construction. Suspended on two jeweled pivots is a soft iron core, inside of the yoke of aluminum which is wound with very fine copper wire. The soft iron core makes the magnetic lines uniform throughout the field, so that the current in the fine copper wire in the yoke, when it moves, will move over a uniform field of magnetism and thus enable us to get nearly equal divisions on the scale. At the top and bottom are two bronze spiral springs which serve to return the yoke to a position of rest. The current enters and leaves the fine wire through these springs which thus serve the double purpose of making connection and of returning the index to its position. The light aluminum pointer, which moves over the scale is shown attached to the yoke and projecting from it at right angles. Enclosed within the case, but not shown within the illustration, are resistance coils which serve to cut down the amount of current allowed to pass into the fine wire on the yoke and thus prevent it from burning out. The amount of current used in such a measuring instrument is between one-hundredth and one-thousandth of an ampere. The construction for voltmeter and amperemeter is the same except in regard to the quantity of resistance and the amount of current used, the amperemeter being an extremely sensitive voltmeter with a different scale over which the needle moves. Voltmeters are made to record as low as one-thousandth volt. Such an instrument is called a millivoltmeter and the amperemeter is simply one of these extremely sensitive instruments with a different scale. They are very finely made, move on jewels like the pivots of a watch, and are constructed of material having such resistance that they may be left permanently in circuit. The amount of electricity used is too insignificant to be noticed and hence all cost connected with their use is limited to the installation of the instrument and any breakage that may be encountered during its use. As the instruments for platers are strongly encased and fixed against the wall, liability to accident is very slight, and if the instruments are used within the range for which they are calibrated, so as not to burn them out, they will last a lifetime.

There is much more to the subject of voltmeters and ammeters than this, of course, but as we only desire to explain the principles of working we will not enter upon the discussion of mathematical, magnetic and mechanical questions connected with the manufacture of measuring instruments.

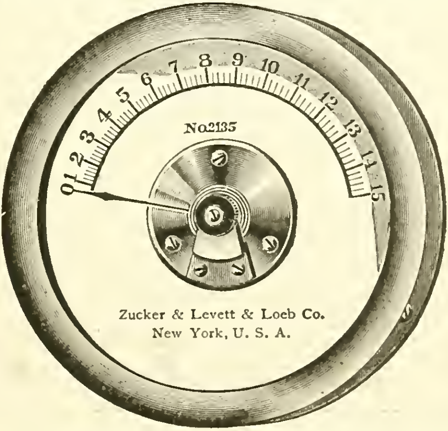

Fig. 61. Voltmeter showing outer case, index and scale.

The voltmeter is about as useful to the plater as is the steam gauge to the engineer. In case the current falls off from any cause, a pressure on the button of the voltmeter will detect it and trouble may be located and remedied before it is necessary to replate a lot of work. As the quantity of current passing through a tank bears a definite relation to the pressure of that current, the value of knowing the pressure instead of guessing at it may be readily seen, particularly, when the plater is running solutions requiring different pressures from the one dynamo, as is the case when using silver, copper, nickel and brass solutions all at one time.

Fig. 61 shows a voltmeter in its case, the terminals for connections not being visible in the illustration. Fig. 62 shows a method of mounting a voltmeter on a board so as to get a number of connections to various points arranged to use conveniently with one instrument. In this case the button marked + is wired to the voltmeter terminal and this is to be connected with the positive main conductor of the dynamo and any one of the lower binding posts to the negative main conductor, so that closing the circuit on this post will give the pressure on the mains. A wire runs from the instrument through a groove in the back of the board to the post of the switch, and each knob in the arc of the circle is wired in the same way to a separate binding post below it. The tank wires are connected to these posts, which are numbered to correspond with the switch knobs, for convenience, and the plater can see his pressure on any tank or the main line by swinging his switch lever to the button connected with that tank and looking at the dial of his voltmeter. No. 20 insulated copper wire should be used in wiring up such a board and the connections in all cases should be made be-

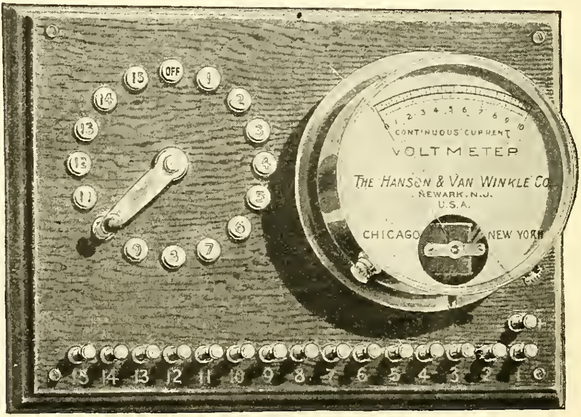

Fig. 62. Showing voltmeter on switchboard adapted to connect at points in the electrical circuit of the plating room.

tween the tank and the rheostat. Fig. 63 shows such a board wired to two tanks and the dynamo. These instruments are cheap and may be obtained from any supply house, either singly as in Fig. 61, or mounted for any desired number of connections as in Figs. 62 and 63.

The amperemeter, while not so important as the voltmeter, is an extremely useful instrument, as it will show directly the number of amperes you are using on any tank or the main line. By its use the plater is enabled to say with certainty just what quantity of current he is using per foot of surface in any tank, thus giving the current density and how much altogether. It is extremely useful in locating leaks and grounds and in telling exactly how much current can be carried on any lead or tap wire, thus pointing out the trouble if the wire is too small. For instance, in the case related in the previous chapter, the ammeter detected an enormous leakage by grounding , in the iron tank, where the voltmeter would merely assure the plater that he had a certain pressure. The amperemeter may be mounted similarly to the voltmeter, as shown in Fig. 63 and placed alongside of it, and if these boards are large enough to contain sufficient

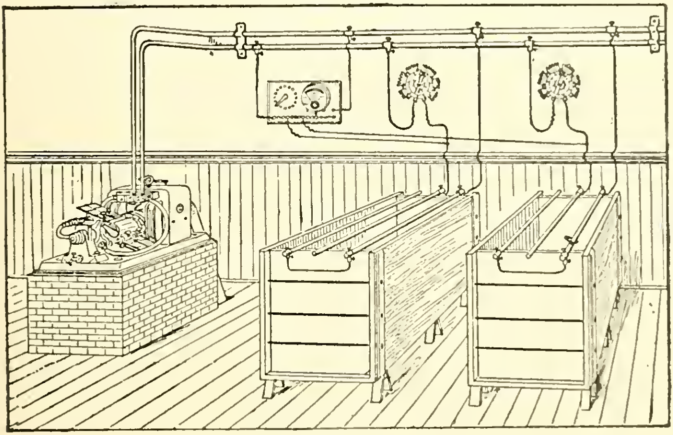

Fig. 63. Voltmeter wired to two tanks and main line.

binding posts and switch buttons, they may be wired to a number of points on the main line besides the tanks. Or if the plater will take a coil of double covered No. 20 office wire, attach one end to a binding post on the board and apply the other to the negative main conductor at various places, he will be able to see the drop in pressure at various distances on his mains or any other point. Such testing will discover grounds, insufficient sizes of wire, bad connections and a host of other things which he needs to know. After such a test the wire may be coiled up again and kept for future use. Care should be exercised to get a good connection before making a reading. The day will come when both these instruments will be considered necessities in the well-conducted plating room.

Rheostats, or "switchboards," as they are commonly termed by platers, have had a steady growth and development but are subject to still further improvement. The original rheostat was simply some German silver wire stretched on a board between tacks, with a switch lever at the bottom of the board, something like Fig. 64. This answered well for a battery, but would burn up in fifteen minutes if placed in a modern dynamo circuit. The principle was retained and the apparatus modified by insulating the metallic parts and making the wire of smaller size in each step so as to make a greater difference in the reducing power of the successive steps. Fig. 64 represents the modern rheostat of this form; flat ribbons of metal have been substituted for the round wire and these ribbons vary in thickness on successive steps as previously described, so that while the width is uniform the amount of metal, and consequently the conductivity, is less. The thin ribbon exposes a much larger surface to the air than a round wire of similar mass, so that the heat is radiated faster and the rheostat will stay cool with a larger amount of current passing through it. The base is of slate and the springs at the upper ends of the strips provide for expansion with the heat. The flat ends also provide for a good contact with the bars of the switch board at their points of attachment, which is one of the weak places in a modern rheostat.

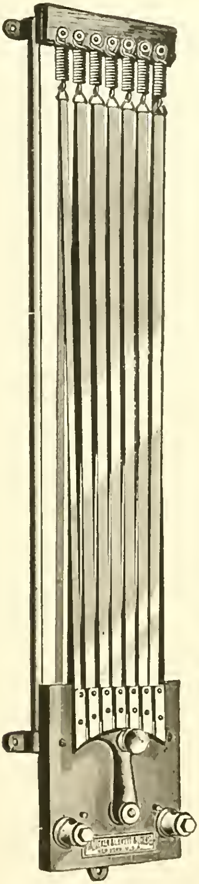

Fig. 64. Rheostat with thin ribbons of resistance metal on slate base.

The trouble in making a permanent joint at this point in all rheostats arises from the difference of ratios of expansion if the contact bar and resistance strip are of different metals, as the same amount of heat will expand one more than the other and if, for instance, an iron wire be put in a hole in a brass bar the brass will expand more than the wire and leave the wire loose in the hole which fits it tightly when cold. If this is very pronounced it makes a bad connection, which will steadily grow worse with use, and the rate of reduction of the current may in time be sensibly altered by the corrosion induced by the bad contact. If this matter be properly looked after in building them no trouble need be experienced on this point, however, unless the plater takes his rheostat apart for cleaning or other purposes; when this is the case he should pay particular attention to the attachment of the sections to their bars.

The contact surfaces of the bars and the similar surfaces of the switch lever should also be constantly looked after while the rheostat is in use. Unless they fit each other perfectly all over the contact surfaces, the current will pass in continuous arc between all surfaces which are separated from one-hundredth to one-thousandth of an inch and this arcing of the current will corrode the surfaces until a proper contact is impossible. When this happens the surfaces of bars and lever must be reground by putting a paste of oil and tripoli on them and working them back and forth until good contact all over is again established after which it must be thoroughly cleaned. This is the weakest point of most of the rheostats now in use, and they fail here most rapidly when the contact surfaces are small in proportion to the amount of current they have to carry. Arcing will also be caused in this way if the springs which hold the lever down firmly on the bars are allowed to get loose, or get "set," i. e., lose their elasticity.

It is a good plan to measure a new rheostat and make a table of the volts and amperes it will carry when putting it up. Then if you suspect trouble here you can get out your table, go to your voltmeter and test the rheostat, step by step, comparing it with the same steps in your table. Bad contacts and any consequent change in the carrying capacity of the rheostat will thus be shown at once. This table is also of great convenience to refer to when questions of current density and variation of solutions come up, as they frequently do.

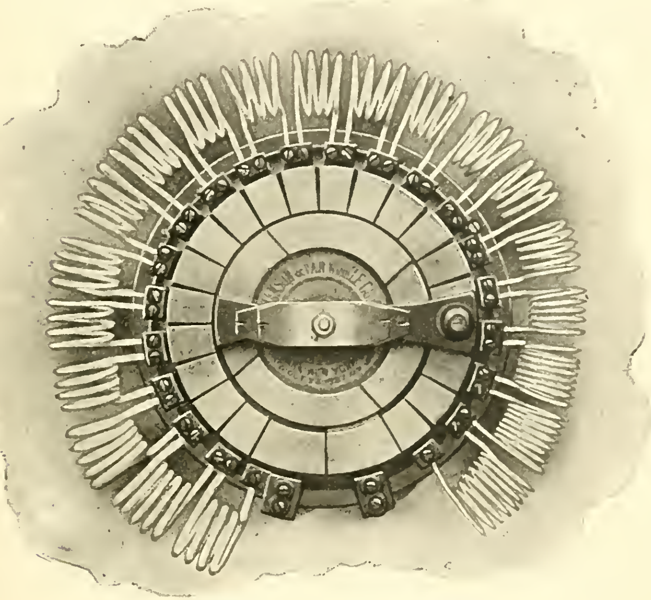

Fig. 65. Rheostat with twenty steps.

Fig. 65 shows a rheostat with twenty steps. It is similar in principle to Fig. 64, but differs from it in using round wire of varying diameter which is curled up to save space and in having the switch lever pivoted in its center and making contact at both ends. It is made of varying capacity and varying number of steps, so as to cheapen the cost on special solutions. The rheostat shown in the illustration has been measured and the following table of its carrying capacity will be instructive to many platers as illustrating the ratio of reduction in quantity of current, which does not follow the same proportions as the reduction in pressure.

VOLTAGE AND AMPERE CAPACITY. VOLTAGE AT TANK WITH BAR ON.

	Volts.	Amperes.
1st segment of Rheostat	4.5	300
2d " " "	4.4	290
3d " " "	4.2	275
4th " " "	4.1	260
5th " " "	3.9	250
6th " " "	3.7	225
7th " " "	3.3	200
8th " " "	3.1	185
9th " " "	3.	180
10th " " "	2.9	170
11th " " "	2.8	160
12th " " "	2.7	150
13th " " "	2.6	135
14th " " "	2.5	125
15th " " "	2.4	120
16th " " "	2.3	115
17th " " "	2.2	110
18th " " "	2.	80
19th " " "	1.9	75
20th " " "	1.8	70

The chief fault found with the ordinary rheostat is its lack of a universal range. The range is of course limited by the number of steps and the more of these the better, if there is a great variation in work. If the work runs moderately even, as in a manufacturing establishment, a stove shop, for instance, or a hollow ware factory, four or five steps may be enough for current regulation. But if it be a job shop and the man in charge be required to plate one stove leg in a 250-gallon tank of nickel then in addition to cutting down the current to the limit of the rheostat, he will probably have to hang an anode on each side of the stove leg, on the cathode rod, to take the brunt of the current and keep it from burning the work. Increasing the number of steps increases the cost of the rheostat, of course, but it is the opinion of most platers that the present range of these instruments should be added to at both ends, as they are subject to undue heating with tanks full of work and fail by giving too much current for one or two pieces.

Figs. 66 and 67 show a new rheostat which is said to work on an entirely different principle from those previously described. There is an absolute drop to a definite standard when the current enters the rheostat and subsequent manipulations do not change the voltage or pressure, but do change the amperes, or quantity. In Fig. 66 are shown two sets of switchbars, each with its own lever; each of the bars in the lower set will carry ten amperes of current at the predetermined drop in voltage; the upper set shows contact

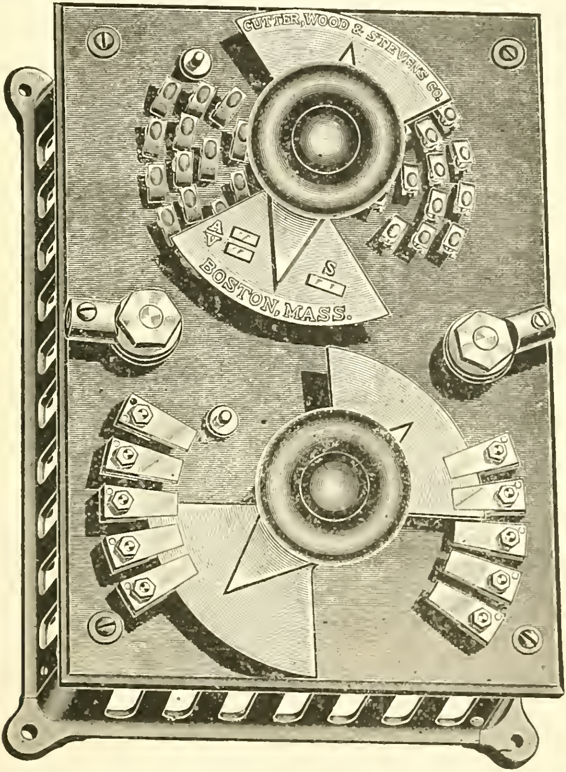

Fig. 66. New Rheostat. The lower bars each carry ten amperes, the upper bars each carry one ampere; giving variations of one ampere up to fifty amperes.

bars of spring phosphor-bronze, staggered, so that they may be switched on one at a time by turning the lever, the ends of the levers are large enough to come in contact with all the bars at once, when the entire current capacity of the machine will be transmitted. The frame consists of a finished slate front mounted on a skeleton box frame of japanned cast iron. On the opposite side of the slate within the box frame are the corresponding resistance units, see Fig. 67. These units are of a special metal fused in porcelain and attached to their respective contact pieces. They are made in various sizes and with initial drop in voltage according to the circuit on which they are to be used.

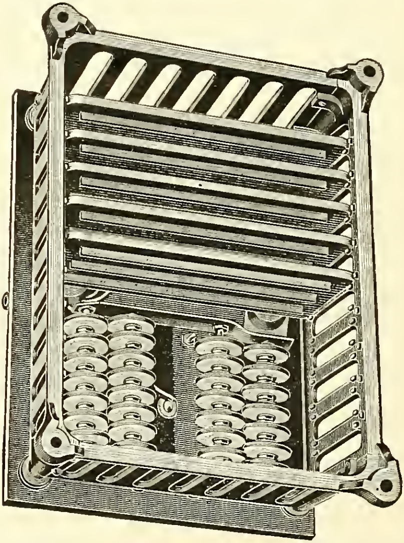

Fig. 67. Interior view of Fig. 66, showing resistance bars in porcelain.

One further point needs to be taken into consideration in studying the line connections, which is that where the conducting mains are shown to be faulty, so that they drop the pressure continuously with the increase of distance from the tank, and the plater is not allowed to increase the size of his mains to what they should be, he can often minimize the evil by placing the solutions in his tanks so that those requiring the highest voltage will be nearest the dynamo, where the pressure is greatest and those requiring the lowest voltage shall be farthest away where the pressure is least. This is simply making the best of a bad state of affairs, but it will often help out considerably where it can be done. In such cases the rheostats, if they are alike, will give different pressures and different quantities of current on the corresponding segments at each tank for the reason that the tank pressure is less as they get further away, so that nothing should be taken for granted but a separate table made for each one from actual readings while at work.

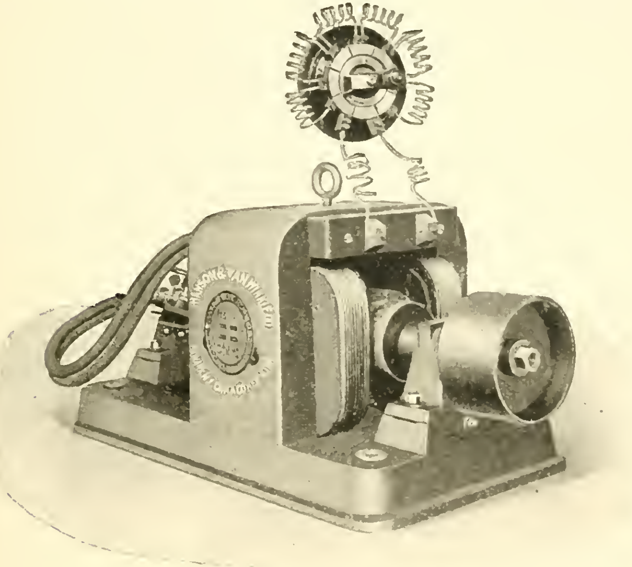

Fig. 68. Showing Rheostat in Field of Dynamos.

In using the ampere meter, one peculiarity of the electrical distribution of power should not be forgotten. That is, the generation of current is in proportion to the work to be done. Thus if you are testing a rheostat with a capacity of 350 amperes, you will not get 350 amperes unless your tank is so full of work and anodes that such an amount will pass through the solution, and the voltage is high enough to put it through. Similarly, if you are using a new dynamo which has a capacity of 2000 amperes you will not get 2000 amperes, unless you have a 2000-ampere load on the machine. This peculiarity of generating current only in proportion to the load is what makes the electrical distribution of power so economical, in addition to its convenience, as previously stated in the chapters on polishing, but it is apt to show in so many ways that the beginner in measurements is likely to be misled unless he bears it in mind when using the ammeter.

The use of shunt wound and compound wound machines allows us to change the voltage of the machine at will, within the limits for which it is wound. This is done by placing a rheostat in circuit with the field coils of the dynamo so that by moving the lever of the rheostat we can increase or diminish the amount of current passing through the dynamo field coils and consequently change the strength of the field magnets. If a greater number of magnetic lines are cut by the rotation of the armature wires the voltage will rise; if less, it diminishes. We can thus change the voltage in a ten-volt machine to anywhere between four and ten volts, by altering the field rheostat. This is useful by allowing us to raise the voltage enough to compensate for the drop in pressure when the conductor is too small, provided that we do not at the same time introduce other troubles, such as burning the work in the tanks which are nearest the dynamo. It allows the use of high voltage on solutions which require it and saves power and burning of work by reducing the output of the machine when little work is being done and that little requires low voltage, such as silver or copper. Such rheostats should always be obtained from the builder of the machine, when it is desired to use them, as he has the mechanical and electrical data on which the dynamo was built and can supply the rheostat which will fit, whereas others would have to guess at it. In ordering such a rheostat the purchaser should always state expressly what it is for and give the make, size and number of the dynamo.

In adjusting rheostats they should be placed as near to the tanks as possible and in the line leading to the cathode rod. The wire should be cut and the severed ends inserted in the binding posts of the rheostat, being careful to use the largest wire which will fit the connection on the rheostat. The lever of the rheostat should rest on the weak point when work is put into the tank, then the lever should be turned toward the strong point until a suitable current is obtained.

CHAPTER VIII.

GOLD PLATING AND GILDING.

Of the many branches of electroplating perhaps the manipulation of the gilding and gold-plating solutions requires the greatest degree of skill and taste. This is due to the cost of the metal and to the necessity of obtaining the very best and richest shades of gold while using as little gold as possible to cover a given surface. Generally speaking the most skillful gold plater or gilder is he who can make a given amount of gold cover the greatest surface and obtain the proper color and finish. For that reason gold plating and gilding in shops where any considerable amount is done, has fallen into the hands of specialists. Platers who may be first-class workmen upon nickel, copper, silver or any of the other classes of work, and who have had no special training upon gold work can do gold plating because they understand the general principles of plating, but the results are usually very inferior and unsatisfactory, the colors being generally pale, brassy, or of a sickly dull shade, while gold generally requires brilliancy and life, or those warm restful shades so pleasing to the eye of the critic and the lovers of art. This pertains as much to plating, especially in gold, as it does to painting or any of the other fine arts. Then, again, the plater without the special experience not only fails to obtain satisfactory results, but he very often deposits more gold than is necessary and sometimes more than the finished job is worth. Those are perhaps the principal reasons why this branch of the business has fallen into the hands of specialists.

Books on electroplating generally treat the subjects in too general a way, taking for granted that the operator already knows what is left unwritten, or that he will find it out by experience, which is usually dearly bought experience, especially with gold work. In no branch of the trade is that slip-shod manner of treating the subject so true as in gold plating, leaving out apparently simple instructions which are of vital importance to beginners and those of limited experience.

Perhaps it will be well to state that the writer of this chapter has had a wide experience upon gold work of all classes and has been at the head of the gold plating and gilding department of one of the largest houses in the country, handling plated jewelry, buckles, purses and bags, metal picture frames and other novelties.

So it will be the particular aim in this chapter to give the most approved methods of doing gold work; to use the most plain and simple language; and also to go into all necessary details, so that there can be no misunderstanding as to what is meant. At the same time, the fine points required by the experienced plater, who may be seeking knowledge to help him through a temporary difficulty, will not be overlooked. It is hoped that by following these instructions any one with the desire and opportunity for practice may become a proficient workman. But it must be remembered that in this as in any other art, the most successful man is he who is wrought with enthusiasm for his work and who has full confidence in his ability to obtain any color or finish desired. He must not only have this, but he must be able to recognize the beauty of a finish when obtained. He must work eye, brain and hand to obtain the most pleasing results.

Art is art in whatever line it may be found, and people with either a natural or a cultivated taste for things beautiful are able to recognize it in whatever form it may be found. The proper blending of colors and shades is as necessary in finishing an article as it is that the article have the proper shape and curves. The coloring and finishing should be such as to harmonize with its surroundings. Here it is that the plater must use his utmost skill and cunning.

Considerable attention should be given to the details in arranging the necessary appliances for gold plating and for the preliminary preparation of the work. Of course their arrangement will depend largely upon the nature and quantity of the work which is to be plated. The subject is too large to attempt to go into details as to the best arrangement for any special class of work. The hot solutions should be heated in a water bath, but this bath may be heated by oil, gas, or steam, according to circumstances. We will attempt to give the best methods in use upon all ordinary work and also the formulas for solutions which we know from practical experience will give satisfactory results upon the classes of work for which they are recommended.

Scratch brushes are indispensable for gilding and gold plating. They consist of circular wheels of one, two, three or more rows of soft crimped medium, or coarse wire, which is usually of brass. These wheels may be obtained from two to six inches in diameter, but those from three to four inches in diameter are most used upon ordinary work; then there are wheels called goblet brushes for inside work, such as the scratch brushing of the inside of hollow ware pieces to be gilded; there are also small end brushes for the brushing of the inside of finger rings, the insides of match boxes or any other small pieces which must be cleaned for gilding. There are also steel wire wheels of different sizes. These are sometimes used in place of brass scratch wheels, but do not give satisfaction, as their use gives the plated article a dull shade which brass wheels do not. They are most useful as satin-finish wheels where a very fine mat or satin-finish effect is required. Upon small gold or plated articles the different sizes of steel wire wheels will be found very useful. An assortment of wheels of various shapes, sizes and number of rows will be necessary where considerable work of different kinds is handled. With scratch wheels, as with polishing wheels, when once put on the lathe and used they should always be put on the same way afterwards; if it is turned and run backward it is liable to scratch the work and spoil the wheel.

The lathe for scratch brushing work for gilding should, if possible, be used for nothing else. It is a bad plan to use the same lathe for scouring work with pumice, or for polishing, as in that case you are sure to get more or less grit and grease upon your gold work, which is a serious drawback to first-class work. Have the scratch brush lathe conveniently near the gold solutions, if possible, as this will save many steps in the course of a day. It should be arranged so that it may be stopped and started easily on account of the necessity of changing wheels often in handling articles of many shapes and finishes, requiring to be brushed with wheels of different shapes and grades of wire. Probably the most convenient arrangement is to have tight and loose pulleys upon the lathe spindle, the belt being easily shifted from one to the other as required. As little oil as possible should be used upon this lathe and counter shaft to prevent its coming in contact with the wheels, work, or the scratch brush liquid.

All scratch brushing either of gold or silver is done wet; there are several liquids used for this purpose, all of them giving very good satisfaction. Perhaps the best and cleanest thing to use is soapwood bark; it is the bark of a tree and may be obtained in a powder or in small chips. A small handful is put to steep in a convenient dish by pouring hot water upon it in the evening; next morning it is ready for use. This will not sour or ferment easily, and where it is not used enough to become dirty, may be used several days without changing. Stale beer is very good and is used by many for scratch brushing, but it has the fault of becoming sticky after being used for a time. Then in some shops it seems to be a difficult matter to keep beer on hand long enough to become stale, especially in warm weather. As a substitute for the above, when they are not obtainable, a little sal soda or lye may be added to the water, just enough to make it slippery or smooth.

The arrangements for applying the liquid to the work are many; some platers use an ordinary pan under the wheel into which the liquid is placed and then applied to the work and the wheel as required while brushing. A suitable can may be set on a standard or hung from the ceiling above the wheel and back of it. The can should have a small pipe or tube attached to the bottom with a stopcock near the can to regulate the flow. The discharge from the pipe should be just over the front side of the brush, near to it, but not to drop upon the brush, as that would throw the liquid. If it drops just in front of the brush it will fall upon the work being brushed, which is as it should be. A temporary can may be made that will answer the purpose by making a hole near the bottom of the can and placing a stick in the hole long enough to carry the liquid to the front of the brush. Have a small notch in the stick at the hole in the can to allow sufficient flow of the liquid. If the stick is given sufficient slant this will be found to work very well.

Some platers place a hood over their scratch brush lathes to prevent any water from flying. They stand at the end of the lathe with the point of the spindle towards them while working. This is the method used in many English shops, but where time is of importance this method would prove too slow, as the hood would interfere with the speed of handling the work.

In gold plating articles that must be wired up, the smallest wire that will answer the purpose should be used, as, of course, the larger the wire and the more of it there is in the solution the more gold will there be deposited upon it. For this reason the same wires should be used as often as possible or until they begin to break, when they may be annealed by heating to redness and dropping in water. When too brittle for use they should be saved and the gold stripped off when a sufficient quantity of wire has accumulated.

As in other plating, it is necessary to have handy a kettle of hot lye; a bountiful supply of clean hot and clear cold water. A box of boxwood sawdust should be at hand for drying the gilded articles. In purchasing this boxwood sawdust it is wise to be sure that it is clean and free from glue of any kind; in some of it, which is made from wood which has been worked up into patterns, or furniture, or anything else where glue has been used, the particles of glue are mixed through the sawdust and readily stick to the wet, gilded article as it comes in contact with the sawdust, thus smearing the work and spoiling the finish. In some cases this requires the article to be refinished and perhaps regilded

Roman Gold or Twenty-four Karat Gold.—For gilding all small articles of jewelry, such as rings, chains, lockets, pins, buckles, etc., the hot solution is usually used, as it deposits rapidly and the color when properly manipulated ranges through a large number of shades, according to the wishes of the operator.

To Make Twenty-four Karat Solution.—The first thing to decide is the quantity of solution that will be necessary to accommodate your line of work. Generally the gold solution is made just large enough to take the pieces to be plated handily; for all small work, such as jewelry, buckles, or small novelties, a half-gallon or one gallon of solution is all that is required.

In a half-gallon solution, from three to six pennyweights of fine gold may be used. When using the smaller amount, of course, the gold in the solution will run out and the solution will become deficient in metal much sooner, so that it will not give satisfactory results as long as will the solution containing five to six pennyweights to the half gallon; but while there is sufficient gold in the solution the results will be satisfactory.

In preparing the solution first weigh the gold to determine just how much you wish to put into the solution; then roll it out as thin as possible with jewelers' rolls. Heat gently with a blow pipe to a red heat. When cool cut it up into small pieces and place it into a porcelain lined evaporating dish which should be kept for this special purpose. Then add, by measure with a graduating glass, two parts of C. P. muriatic acid and one part C. P. nitric acid. Add the nitric acid slowly, stirring with a glass rod. Now place the dish in a sand bath over a gentle heat, which may be increased somewhat as the dish becomes warm. Do not use too much heat or you will drive off the acid before the gold is dissolved. It should boil up somewhat and fume as the acid becomes hot and reduces the gold. Usually an ounce of muriatic and one-half of nitric acid will suffice to cut down five pennyweights of gold.

It is immaterial if a little too much acid is added; the only drawback is that it takes that much longer for the acid to evaporate; but the proportions should be nearly exact. If too little acid is added, some of the pieces of gold will remain undissolved and a little more acid should then be mixed and added to the dish until all metallic gold disappears. Then the dish should be allowed to remain upon the heated sand until the acid evaporates to the consistency of syrup and has a reddish-brown color. The heat should now be reduced and the dish allowed to remain on the sand, tipping it from side to side occasionally to spread and evaporate the acid quicker, and also to prevent the gold from burning to the side of the dish. Care must be taken to avoid using heat enough while evaporating the acid to cause the gold to burn on to the sides of the dish, as in this case it becomes a metallic powder and more acid must be added and the gold redissolved, thus delaying the operation.

Now this brown deposit upon the bottom and sides of the dish is the chloride of gold and many platers rinse out the dish when cool and add the gold in this state to the solution dish, adding enough cyanide of potash to neutralize any remaining acid and take up the gold in solution. Where a pure gold solution is required for fine gilding this practice cannot be recommended, for the reason that nearly all so-called fine gold, which is supposed to be twenty-four karat, is usually twenty-three or even twenty-two karat. Consequently, if you use the gold as it is cut down, without any precaution for removing any alloy which may have been in the gold, your solution cannot be a fine gold solution, but will contain the alloy which was in the metal before dissolving with acid. This alloy usually consists of silver or copper. Either metal, if present, will have detrimental effects upon the deposit.

To avoid the possibility of getting any foreign metal in the fine gold solution, take two sheets of filter paper of convenient size (one breaks too easily when wet); place the folded paper in a glass funnel, wet the paper with a little cold distilled water; then rinse down the sides of the evaporating dish containing the gold with warm distilled water and run it through the filter, pouring it slowly into the filter and letting the filter discharge into the vessel which is to contain the solution. If there is any alloy in the gold a sediment will be present in the evaporating dish when the water is added. All the contents of the evaporating dish should be poured into the funnel. Nothing but the gold which has been dissolved will go through the paper. When a sufficient quantity of distilled or pure soft water has been added to make the required amount of solution, C. P. cyanide of potash should be added in small quantities and the solution should be stirred with a glass rod until it assumes an almost colorless appearance, when it will be ready for use. This solution is worked hot and the temperature at which it is kept has much to do with the color of the deposit. The proper temperature for obtaining a fine yellow or Roman gold is from 120° to 130° F. If the solution is run at about 80° to 90° F., the color will be lighter and more brassy, or pale, while if the temperature is run up to 140° F. or more, the deposit will be of a darker or reddish shade.

The amount of current also has considerable effect upon the color of the deposit, a weak current producing the lighter shades, a medium current the rich yellow color, while the stronger the current used the redder will be the color.

Ten pennyweights of fine gold makes a very convenient anode for this solution. It should be rolled out about one inch wide and from two to three inches long. It should be annealed before using, as it will then dissolve much more readily with a weak current. The rule that the anode surface should be as large as the cathode surface, or nearly so, does not apply to gold plating. In fact, the object being plated may be and often is ten times as large as the anode. Generally speaking, anything that can be gotten into the solution may be gilded with an anode of the size mentioned above. The reasons for this are that fine gold is very readily dissolved and deposited by electricity. Gold anodes, either fine or alloyed, should be removed from the solution when not in use, the cyanide in the solution having a tendency to dissolve the gold. The action is very slow and an hour or two more or less in the solution may make very little difference. But there will be a noticeable difference in the weight of a gold anode allowed to remain in the solution over night. It is best to use a platinum wire for connecting the gold anode, especially where a twenty-four-karat solution and anode are used and fine coloring is desired. The platinum wire is not affected by the current. Consequently it will last indefinitely; from three to four inches is all that will be required, just enough to attach one end to the anode and the other to the anode wire, thus keeping the copper wire from coming in contact and becoming dissolved by the current in the gold solution. Of course, this practice is not necessary for karat solutions and is only recommended where the finer grades of gilding are required. The solution being used hot gives it greater conductivity.

A surprising amount of plating or gilding may be done with one-half gallon of gold solution and a ten-pennyweight anode. If handled with skill and economy such a solution, where used every day, will give good results from five to six weeks and will turn out anywhere from $100 to $150 worth of work at ordinary prices.

It is generally best to make a new solution after the old one has been used for some time and the deposit becomes off color, though by filtering and adding a little fresh chloride of gold the old solution may be made to give good results again.

If insufficient cyanide is added to the solution the deposit will be very slow and off color; if too much cyanide is present the color is liable to be pale or brassy. At times the gilding may come off when being scratch brushed; this is usually caused by a surplus of cyanide; the solution being too hot will also cause it, as the deposit is forced on too fast and does not properly adhere to the article being plated. In this case the heat and current should both be reduced. Gilding solutions usually become too red with age, giving more of a brown color rather than a fine gold color. This may be remedied by the addition of very small quantities of silver solution, not more than a tablespoonful to the gallon, as too much would give a green shade, which is not desired in ordinary gilding.

Preparation of Work.—In preparing the work for gilding all grease and dirt should be removed by the use of hot lye, followed by scratch brushing with a soft, brass wire, circular brush, suitable for the class of work, brushing the work wet, using one of the fluids previously described. This should leave the work clean and bright. Then it is rinsed in clean water and wired and immersed immediately in the gilding solution. In gilding the stringing wire is not twisted or hung on to the battery wire or rod, but is held against it by the operator, as the work is in the bath so short a time. Connection should be made before the work touches the bath. For coloring small work, where the finish is more the object of the operation than the thickness or amount of gold deposited, the work should not remain in the gilding solution for more than a few seconds for the first operation, and it should be agitated or moved from side to side continually, which insures a brilliant and even deposit. Then the articles should be quickly removed, rinsed in a special vessel of hot water, which, if kept clean and free from dust and dirt, may be used to fill up the gilding solution as it evaporates. After rinsing the article is scratch brushed lightly, using plenty of soapwood water or stale beer. This burnishes the gold down evenly all over the article and it is then rinsed again in clean water and again immersed in the gilding solution for a few seconds. Watch the work closely and remove it as soon as the desired color is obtained. Do not scratch brush after the last immersion, but rinse in cold and then in clean hot water and dry in boxwood sawdust. This finishes the operation, unless some parts of the article are to be burnished. Or perhaps it may be work that will be improved by lacquering.

There is no end to the different classes of small articles that require gilding in the shape of both expensive gold jewelry, cheap jewelry and novelties. Nearly all fine jewelry is gilded for one purpose or another. It may be to get one of the several different effects, such as Roman gold, Guinea gold, Old English gold, Rose gold and so on, or it may be that the gilding is only intended to give uniformity to the back or inside of a piece or to hide any discolorations caused by the pickle or fire and to facilitate the polishing.

It seems to be one of the difficult things in gold plating and gilding, especially the latter, to get little enough gold on the surface of the article being gilded. It is the prevailing idea among amateurs in this line that articles should be allowed to remain in the solution for some time, as is done with other plating, such as silver or nickel. This is a mistake and it forms one of the principal causes for failure to make money in gold plating. The rule in silver or nickel plating is usually to get sufficient deposit; the finishing being a secondary matter. The reverse is the case in gilding or gold plating; the object here is generally to get the desired finish or color as quickly as possible, with the expenditure of as little gold as can be used. Usually, *when the desired shade is obtained sufficient gold has been deposited.* This is the plan in handling all cheap work. Of course, work requiring a heavy gold plate, for which a good price is paid, takes longer, is given several immersions in the solution and the immersions are of longer duration. They depend entirely upon the thickness of deposit required. But, in any event, the work is never allowed to hang suspended in a hot gold solution for any length of time; the solution being hot, the gold is deposited very rapidly, and if allowed to hang undisturbed the deposit would soon become very heavy, but soft and spongy, presenting a poor appearance and not possessing the necessary wearing qualities. The proper method is to hold the work while plating, agitating gently and removing it every few seconds and scratch brushing, then repeating the process as often as necessary to obtain the desired thickness of deposit.

Roman gold usually requires a chased or matted surface effect to bring out the color of the gold in its most brilliant shades. The matting is done by the use of the sand blast, using a suitable grade of sand according to the grade of finish required, fine or coarse. Where a dead or dull finish is required the sand blast is the proper thing to use before gilding the object, after which it is prepared in the ordinary way for gilding. All manufacturing jewelry shops, no matter how small, have a sand blast. In fact, it would be difficult to do without one where much gilding is done, as it is available on work where a wheel cannot be used, such as the inside of rings, lockets, borders of small spoons, etc. Powdered glass, made by heating scrap glass to a red heat and dropping it one piece at a time into very cold water, and then running through a sieve, gives brighter effects than sand or emery and is largely used on soft metals, such as gold and silver.

There are many kinds of wheels used for satin finishing or matting, all being more or less useful on the different classes of work. The swing brush is made of wire tassels of the proper size of wire tightly bound together by wire, and each tassel is secured to the wooden hub by means of screw eyes. These wheels have been in use many years on jewelry, silverware and Britannia. While new, and if run at the proper rate of speed, they give very good results, but the wires soon become bent out of shape, after which good uniform work is hard to obtain.

The regulation steel scratch brush is very useful in satin finishing and by using a brush of fine wire a very delicate matted effect is obtained upon either gold or silver. These wheels must not be run too fast, as in that case they are apt to scratch and not mat. In using the steel scratch brush wheels for matting, the front or flat edge of the wheel must never be used. The best finish is obtained from using the corner or edge of the wheel, with a very light pressure. When these steel wheels become greasy or dusty they should be washed out in hot potash, as the dirty steel wire leaves a greasy scum upon the work which is hard to remove. Any wire wheels, either brass or steel, should be cleaned in this way whenever necessary. The best matting or satin finish wheels in use to-day are those which have the wires loose so that they will spring or turn on the hub when striking the work. There are several ways of accomplishing this, the means varying with the several manufacturers. If the wires have sufficient play in the hub, this wheel gives an even and very lustrous surface to almost any metal, which makes a bright and pretty effect after being plated.

FOURTEEN KARAT GOLD PLATING.—There are several formulae for fourteen karat solutions. The character of the work and the methods of handling will decide which is the most suitable solution for any particular class of work. Articles which are to be plated and afterwards burnished, such as watch cases and jewelry or any article which is to be given a heavy and durable plate, are handled in a solution composed as follows:

Water	1 gal.
Cyanide	10 oz.
Chloride of Gold	10 dwt.
Carbonate of Copper, sufficient to obtain the desired shade.	

Dissolve the cyanide in the water; then add the chloride of gold, which has been previously prepared as described under the head of gilding. Now dissolve one-half ounce of carbonate of copper in cyanide, adding the clear copper solution to the gold solution very gradually, while the latter is plating on actual work. The solution should be heated to the proper temperature for work, while the copper solution should be of the same temperature, so that all the conditions may be as nearly right as possible. 140° F. is about the proper temperature. While the copper is being added, the work should be gently agitated and removed from the bath from time to time and scratch brushed to ascertain the exact shade of the deposit. Care must be observed not to add too much copper, for if the solution plates too red it will require the addition of more gold chloride to bring it back to the desired color. It is always best to stop adding the copper just before reaching the desired shade—that is when the solution is plating a shade or two lighter than that really wanted—because when the solution becomes thoroughly mixed and has been used for a short time it is very liable to plate a little darker than when it is first made.

A fourteen karat anode should be used with this solution made of fine gold alloyed with oreide. This is an alloy composed of copper, 80 parts; zinc, 83 parts; nickel, 6 parts;

with a trace of iron and tin, and is much used by jewelry manufacturers. The object in using oreide in the anode is that it does not tarnish and therefore gives better results in plating than would an alloy of either copper or silver. The latter should always be avoided in karat solutions, as they tend to give an inferior color and a deposit that will readily tarnish.

In preparing work for plating in this solution, particular attention should be given to the cleaning, as any finger marks or grease spots will interfere with the burnishing and show through after the article is finished. After cleaning and scratch brushing thoroughly, rinse in clean water and hang the work in the bath. Do not let it hang undisturbed, but agitate gently; after about one minute remove the article and scratch brush; then repeat the operation as often as necessary to obtain the required deposit. Usually about three immersions is sufficient to obtain an ordinary plate; but if any particular amount of gold is required upon an article it may be weighed before going into the bath and then weighed from time to time as the operation proceeds until the desired weight is obtained. The burnishing of this class of work adds greatly to its appearance and utility, hardening the deposit and closing the pores of the metal, thus doubling the time which the deposit will wear.

The foregoing solution is used mostly where heavy deposits and burnished finishes are required, something calculated to wear and give satisfaction. It is not in general use, except upon the better classes of gold plating. The following formula is in very general use where large quantities of work, beauty of color and finish are required, usually at the expense of the wearing qualities of the deposit. It is highly recommended for cheap case plating and other like work, where appearance is the main point to be obtained. At the same time a very good and lasting deposit may be obtained from the same solution, if manipulated as previously described for heavy plating. This being a bright solution, burnishing is not necessary to obtain a high polish, but it should never be omitted where the plate is guaranteed to wear for a certain length of time. To prepare the solution for bright plating, take ten pennyweights of fine gold and reduce to chloride as described for gilding. Add this to one gallon of distilled or clean rain water, adding C. P. cyanide of potash gradually, with stirring, until the solution becomes colorless. Then cease adding the cyanide and add one and one-half ounces of carbonate of soda. Now put ten pennyweights of carbonate of copper (or cyanide of copper will do) in a dish or bottle with a little water and a tablespoonful of ammonia; add cyanide slowly to the bottle and shake until the copper carbonate is dissolved and the solution becomes of a straw color. Now bring the solution to a temperature of 130° F. Hang in the anode, which should be of fourteen karat gold, using oreide for alloying the fine gold and nothing else, this being non-tarnishable:

Fine gold	10 parts.
Oreide	8 parts.

Will give a fourteen-karat anode.

Stir up the solution well and proceed to plate, using a fairly strong current. Now add the copper solution from the bottle slowly, with stirring, while the work is suspended in the solution, watching closely until the desired shade is obtained upon the article being plated. Work to be plated in this solution is not to be scratch brushed before plating, but should be very highly polished and buffed clean, removing all rouge or grease with the buff, if possible. Now the work is wired and potashed, rinsed up and down in the hot lye and brushed with a soft brush if necessary; then rinsed in clean water; then in a clean, weak, cyanide dip, just strong enough to remove the tarnish from the article; then rinse again in water and hang into the plating bath at once.

The plating in this solution is usually done with one application. The work upon removal from the solution is rinsed in hot water and dried in boxwood sawdust, or with soft muslin cloths. It is then finished upon the soft buff with soft or powdered rouge mixed with alcohol and water to a thin paste. Gold rouge should always be used for this class of work. If done by an experienced hand, a very beautiful finish and high polish may be obtained with the buff, while but slightly affecting the thickness of the deposit.

The solution is used extensively upon cheap watch cases and where handled in large quantities by an expert they may be plated and finished at a profit at from thirty to fifty cents each. Of course at this price the wearing quality of the article is not considered, only the present appearance.

Another bright plating solution which is in general use upon watch cases and other similar work requiring a cheap, bright and non-tarnishable deposit is composed as follows:

Fine gold	1 oz.
Oreide	10 dwt.
Nickel	4 dwt.

Melt and roll into a fourteen karat anode. After rolling to the proper size and thickness it should be annealed, so that it will dissolve more readily.

Take one gallon of distilled or rain water, into which a small porous cup has been placed; half fill the cup with the cyanide and water; then set it upright into a jar containing the remainder of the cyanide solution. Attach a piece of platinum to the work rod or wire from the dynamo and suspend it into the porous cup; hang the gold anode into the outer jar and turn on a strong current. If no platinum is at hand, an arc light carbon, a nail, or small piece of clean steel will answer. The gold will be dissolved from the anode, and not being able to pass through the porous cup, will remain suspended in the cyanide solution. A solution may be made ready for use in about half an hour or longer, according to the amount of current used and the amount of gold required to run the solution. From five to six pennyweights of gold to the gallon is usually sufficient. To determine the amount of gold in the solution the anode should be weighed from time to time. When the required amount of gold has been drawn into the solution, the liquid in the porous cup is added to that in the jar and the solution heated to about 130° F., when it will be ready for use.

In using this solution the handling and preparation of the work before and after plating is the same as given in the previous formula.

This solution gives a hard, bright deposit, taking a high polish easily and being non-tarnishable.

The porous cup scheme may be used in making fine gold solutions for gilding, especially in cases of emergency, where there is no time to prepare the solution in the ordinary way. The great drawback to making a gilding solution by the use of the current and the porous cup is the fact that nearly all so called fine gold has more or less alloy, usually silver and copper, which becomes a part of the solution when made in this way, thereby causing the solution to give inferior color when finished and tarnishing easily afterwards. Care must be taken in making a solution in this manner not to get too much cyanide into the solution or the deposit will be off color, or perhaps there will be no deposit whatever, if the cyanide is greatly in excess; so it is best to have too little rather than too much.

This form of gilding solution is not in very general use, unless the gold being used is known to be perfectly fine, as it is absolutely necessary to eliminate all alloys or foreign metals in order to get the best results in coloring or gilding. Platinum is very often used in connection with or in place of fine gold, or karat gold, anodes for plating. Some platers claim to be able to do better and cheaper work with the platinum anode; but this cannot be, as the current has no effect upon the platinum, it not being dissolved when plating or gilding, as is the gold anode; consequently the solution is being robbed of its metal, while with the gold anode it is fed from the anode as the gold is deposited on the work from the solution.

Platinum anodes are very useful for several reasons. For instance, when an extra large surface is to be gilded and the gold anode does not present surface enough for the proper distribution of the current, the platinum anode comes into play in the absence of sufficient gold with which to make additional anodes. Then, in using old solutions that it is desired to get the gold out of, the platinum anode may be used, and as nothing is put into the solution from the anode while plating, the gold will soon be entirely removed from the solution. Electric light carbons may be used as anodes in the same way and for the same purposes. They are much cheaper and equally effective, although a larger surface must be immersed.

Where convenient, platinum wire should be used upon all gold anodes to form the connection between the anode and the electric wire or rod. This prevents getting foreign metals into the solution, as is always the case when using copper or other wire.

For gilding the inside of hollow articles, such as sugar bowls, creamers, spoon holders, cups, mugs, etc., any of the fine gold or gilding solutions may be used and sometimes the karat solutions are used. The best way to do this is to have a flat copper plate with a copper wire attached (soldered) long enough so that the plate may rest on the bench while it is connected to the work rod by the wire. Attach this wire to the work rod. Now set the article to be gilded inside upon this plate, the work having first been thoroughly cleaned and rinsed fill the dish to be gilded even full of gold solution, using a cup or other handy vessel which should be earthen or glass and never be of metal. Have the anode ready and place it in the center of the solution in the dish being gilded; immerse as much of the anode as possible, if the surface to be colored be large. The anode should not be held in one position, but should be moved about, getting as near as possible to the most remote parts or corners of the dish to be gilded without touching them. If this is not done the parts farthest from the anode will be of a lighter shade than those parts more nearly exposed to the anode. Care must be taken not to allow the anode to touch either the bottom or sides of the article being gilded, for if it does it will cause a nick or hole to be burned in the metal and perhaps spoil the job. Considerable current should be used when gilding inside work, especially on large pieces, and as much speed as is consistent with doing the work properly. The reason for haste is that when the current is not on the work, either before or after the gilding, the cyanide of the solution will readily attack the plating, which not only has a bad effect upon the plate, but upon the solution also. From one to two minutes is generally long enough for the first gilding. The solution should be at once emptied into the solution jar, the article rinsed and scratch brushed, rinsed again and then given another, but lighter or quicker, gilding, as previously described. This second gilding is not to be scratch brushed, but rinsed and dried.

A very good, bright gilding solution, which does not require heating, but is used cold, is made as follows: Dissolve six ounces of C. P. cyanide of potash in one gallon of distilled water. Then run into this six pennyweights of fine gold from the anode, through the porous cup, as previously described. Add two ounces of carbonate of soda. Boil the mixture for a few minutes and allow to cool. It is then ready for use.

The work must be perfectly clean when it goes into the solution in order to avoid the necessity for scratch brushing, as it is supposed to be finished after a single immersion in this solution, unless some parts may require burnishing. Work this solution with a weak current and keep the solution covered when not in use to prevent it from becoming dirty.

A very good cold gilding solution which is in use in many extensive plating shops where cheap gilding is required upon picture frames, trimmings and novelties of the different kinds, is made as follows:

Distilled water	1	gal.
Chloride of gold	6	dwt.
Potassium ferrocyanide	2	oz.
Carbonate soda	1½	oz.

When the solution is prepared, boil thoroughly, filter and allow to cool, when it will be ready for use. Use a fine gold anode. A platinum anode may be used by frequently adding chloride of gold to the solution, according to the amount of work being plated.

The following is a formula given me by a plater who was formerly an employe in the plating department of the Elkington Co., Birmingham, England. I have never had occasion to use it but am informed that it is very desirable for turning out large quantities of good work cheaply.

Reduce one ounce of fine gold to chloride. Add this to four gallons of water, acid and all, just as it comes from the evaporating dish. Then add four pounds of bichromate of potash; if the mixture appears green, add more potash; bring to the boiling point and then add two ounces of C. P. cyanide of potash, which should turn the solution to a light brown color, when it is ready for use.

Iron, steel, lead or soft soldered articles should receive a coating of copper before being gilded, as fine gold does not adhere well directly upon these metals. The karat solutions, however, will plate directly upon them.

To obtain the bright burnished finish seen in cups, goblets and other hollow ware, the article is usually burnished on the lathe after being silver plated. It is then rinsed in potash and clean water; then filled with the hot solution, first making a connection with the work rod or wire; then immerse the anode, taking care not to leave it in too long, as that would cause the gilding to become clouded. Either the fine gold or the karat solution makes a fine gold lining to a dish when it has first been burnished. The articles may also be first gilded and burnished afterward, getting a similar result, but burnishing the silver and then gilding is the most common way and gives the best results.

SPOT GILDING OR STOPPING OFF.—Articles of silver or silver plate having figures, leaves, flowers, etc., requiring to be gilded, are cleaned just as for gilding, then dried, and then the parts which are to remain silver are painted, using black asphaltum paint made by dissolving two parts of asphaltum and one part of beeswax, with benzine, using just enough benzine to make a thin paint. Now paint the parts which are not to be gilded, using a fine pointed camel's hair brush, so that work may be done neatly. Upon the proper painting of the article depends the success of the whole operation; for difficult pieces it requires patience and a steady hand to insure success. After the article has been painted and allowed to dry, it is ready to be gilded in one of the cold solutions; the hot gilding solution may be used, but the hot solutions attack the paint, so that the thing being gilded must remain only long enough in the hot bath to become colored; therefore the cold bath is superior for this class of work. When the article has been properly gilded, rinse and immerse in turpentine until the paint is removed. Then finish in the ordinary way, removing the turpentine with hot potash, or strong soap water. Small pieces requiring to be spot gilded, or re-gilded, such as fancy spoons which are engraved (bright cut), may be given a coating of lacquer upon the engraving or parts to be protected; dry well and gild quickly, afterwards removing the lacquer in hot potash or by rubbing it with alcohol.

In gilding large vessels, such as loving cups, punch bowls, etc., which have uneven or perforated edges, making it impossible to fill them even full of solution, the sides are built up with gutta percha. First heat the gutta percha in boiling water until it becomes soft enough to work with the hands; now build up the edge evenly around the dish with a wall of gutta percha. Then fill with the gold solution and gild as previously described for gold lining. Another and more simple way of reaching the same end, where the surface is not too great, is to gild the vessel as high up as possible by filling it as full as is possible without spilling Then empty and rinse. Finish the operation by the use of the "doctor." To make a doctor, take a small clean piece of sponge around which the end of the gilding anode is wrapped; then connect the vessel being doctored with the work rod; wet the sponge in the gilding solution and apply it to the parts left uncolored. If the space to be doctored is large the dish should be rinsed from time to time, as the cyanide in the solution attacks the plating and if strong will remove and discolor the gilding. After all is coated, scratch brush the whole surface.

Still another way to gild the uneven or projecting parts of a dish to be lined with gold, is to fill the dish as before and as high as may be without running over. Now gild this much of the dish; remove the gold solution from the dish and rinse. Then proceed to plate the parts where the gilding did not reach by immersing that part into the gilding solution and plate it as you would any other article. Be sure the gilding solution laps well over the part already gilded. When one part is gilded take another and so on around the dish till all is complete; then scratch brush the whole dish. Remember that after each section of the dish is gilded, it must be rinsed in clean water to prevent the cyanide from removing the gilding. Of course this will necessitate getting gold on the outside of the dish. If the gilding is to be done in a cold solution, the outside of the dish may be lacquered to prevent the gold from adhering when the dish is immersed. If the dish is of sterling silver, the gold may be removed by polishing off with tripoli and finishing in the usual manner. If a plated dish, the gold on the outside may be covered up with the silver doctor and finished in the ordinary manner. In gilding sterling dishes that are heavily embossed with figures and flowers, the insides sometimes have deep recesses which are hard to get at with the scratch brush and, being left white from the pickle when the dish is made, these places are usually hard to cover with gold. To gild such dishes, use a rich solution with plenty of anode surface, moving the anode as near to the depressions as possible.

GILDING WITHOUT THE USE OF A DYNAMO OR BATTERY.—This may be accomplished by taking the ordinary gilding or gold plating solution and heating as usual. Now take a piece of copper wire; attach to this the article to be plated or gilded; to the other end attach a small piece of sheet zinc, bending the wire in the center in a U shape. Now immerse both ends, with the zinc attached to one end and the article to be plated to the other; the two ends should not be more than one to one and one-half inches apart. The article having first been cleaned in the proper way will take on a film of gold very quickly, which can be finished in the ordinary way.

Silver plating may be accomplished in the same manner, but any method of dipping or simple immersion is only a makeshift at best, only being employed occasionally in cases of emergency. But as a commercial pursuit the practice is almost obsolete in this age of electrical advancement. For that reason very little space will be given to a practice we consider not up-to-date, nor adapted to the requirements of the present day. So, in passing, we will give only one or two of the simple immersion formulae for both silver and gold, for the sake of completeness. Solution for simple immersion gilding:

Chloride of gold	2 drams.
C. P. cyanide	10 drams.
Caustic potash	5 drams.
Phosphate of sodium	9 drams.
Water	½ gallon.

Dissolve the cyanide in half the water; then add to this the chloride of gold. Dissolve the caustic potash and phosphate of sodium in the other half. Mix the two together and bring to the boiling point. This is adapted for brass, copper or German silver, iron or steel goods, which must first be copper plated. Clean the work well and move about in the bath on a wire from one to two minute

Rose Gold.—While the gold plating and gilding in general require perhaps the highest degree of skill on the part of the operator, in bringing out the different shades and effects and in matching colors in rose gold the operator is not only required to use all his skill and ingenuity, but he must have taste and an artistic eye in order to produce the different effects and to be able to make them harmonize with their surroundings. In order to do this properly the operator should be a lover of art and a critic of artistic finishes. For instance, a base or tray or any other object of antique pattern would look absurd if finished in a bright yellow shade of rose gold. In that case we would defeat the principal aim of the object which is to give the appearance of having come by its present finish from age. Therefore the heavier and more somber shades would be more suitable and in better harmony with the design. On pieces of jewelry and bric-a-brac of new and original design the more heavy shades of rose gold would be out of place, while the lighter and more lustrous shades would be considered the proper thing. However, a great deal of this work, especially in the jewelry shops and job plating shops, is customers' work and of course must be finished to meet the ideas of the party paying for the job, no matter whether those ideas are right or wrong from an artistic standpoint.

While there are many shades of rose gold, and platers will produce different results upon similar work, yet it is a fact that there is probably little if any difference in the solutions. The difference lies with the operator and is due to the fact that people's ideas and tastes differ vastly as to what is appropriate. Then again some men have considerable artistic ability while others have none.

Rose gold solution is made as follows:

Chloride of gold	8 dwt.
Carbonate of copper	10 dwt.
C. P. cyanide	6 oz.
Water	1 gal.

Prepare the solution exactly as described for gilding; then add the carbonate of copper slowly, having previously dissolved it in a little cyanide of potash and water. When adding the copper keep the solution at about 130° to 140° F. and stir up frequently, trying it often upon the regular work, until it begins to run into the proper shade; then add no more copper, as the color will have a tendency to run darker as the solution becomes older. A ten karat anode, composed of gold and copper, works well with this solution, though where there is plenty of gold in the solution, or enough to prevent tarnishing, a copper anode is sometimes used; and, by experienced platers, platinum or fine gold anodes are used.

The whole secret in getting the different shades is in the proper manipulation of the current, the temperature of solution and the handling of the work while in the solution. With these details properly understood, and with the assistance of a good gilding solution, one may produce almost any shade in rose gold.

An old gilding solution that has become run down and weak in metal is frequently made the basis of the rose solution by the addition of suitable quantities of copper carbonate. Also the tone of the rose solution may be brightened by the addition to it of the run-out gilding solution. Some shops doing large quantities of work dispose of all their old gold solution in this way. If the color of the rose solution becomes too dark, or dead, a little chloride of gold should be added which will immediately lighten the shade of the deposit.

Preparation of the Work.—The work to be rose gold is prepared for the bath as for gilding, but only the first preparation; after that it is handled entirely different.

Right here I wish to say that some articles are not adapted to the finish; for instance, flat, smooth or plain objects without border, chasing, flowers or background, with which to give effect to the finish. Yet many times people with little or no artistic taste wish such articles to be finished in rose gold and perhaps want them to match a sample composed of figures or flowers giving a desirable ground to work upon, while the plain surface they bring to you gives you nothing upon which to work. Such jobs are usually unsatisfactory to the operator as well as to the customer and should not be undertaken until the result is explained beforehand. In preparing the work for the rose finish, clean and scratch brush as for gilding, then immerse in the rose solution, gently agitating all the time, watch closely and when the deposit has become even all over and of a dark brown shade, remove the work and rinse. One to two minutes is usually sufficient and the time is much less if the current be as strong as it should be. Now the front of the article, or the part requiring the rose finish is rubbed over with saleratus (baking soda, bicarbonate of soda) with the fingers or palm of the hand, to remove the brown sediment from the high lights and give effect to the finish. The back or bottom of the article is to be scratch brushed, then rinsed and immersed in the gilding solution until the scratch brushed parts and parts exposed by rubbing have been given the proper color. It may be necessary to remove the article from the gilding solution and rub with saleratus more than once before getting the desired color. The same is true in the rose gold solution; an article may often have to be given more than one application and in case the article being plated seems to have bad spots which fail to take on the proper color, the whole thing should be thoroughly scratch brushed and the operation repeated. Grease, dirt or finger marks may cause the work to come from the rose bath in a spotted condition. After the desired color has been obtained by the combined use of the rose gold and gilding solutions the work is dried in saw dust, which is the end of the operation unless it is deemed advisable to burnish the high lights, or to lacquer the work.

In lacquering rose gold, the work should be done with a brush and not dipped. Put on the lacquer sparingly, as when applied thickly it gives the work a painted or varnished effect. A very gentle heat should be used in drying the lacquer, otherwise the work may be discolored or faded by the heat.

Green or Antique Rose Gold.—This effect is accomplished by first getting a nice color and finish in the rose gold and gilding solutions and finishing in the green gold, which is made by adding small quantities of cyanide of silver solution to some of the gold solution. Have the solution warm, not hot. Use a small platinum anode for the best results.

Perhaps the best colors and softest effects in rose gold are those obtained by first silver plating the article to be rose finished, afterwards gilding in the fine gold solution.

Take the object to be rose gold and clean in the ordinary way; plate slowly in a good silver solution until it begins to turn from pearly white to dead white; then remove, rinse, rub off the highlights with saleratus; rinse again and gild. The parts rubbed off will take on a bright gilding while the dead white of the silver deposit gives an excellent rose gold effect, after being gilded. To still further increase the contrast and beauty of this operation, the highlights of the silvered article may be burnished before gilding, which will give it a burnished effect after being finished.

Usually one immersion in the gilding solution is sufficient to bring out the proper color; if not it may be removed from the bath and rubbed with saleratus, scratch brushed where necessary and returned to the gilding bath. This is one of the quickest and most economical methods of doing rose gold. It also gives the most pleasing results.

A very cheap imitation of rose gold is accomplished by giving the work a dip in the gilding solution, getting the proper shade, and afterwards rubbing in the chased work or background yellow and red water-color paints mixed in proper proportions to get the desired color, then, after the paint is nearly dry, wipe the surplus paint from the high parts with a damp cloth. The colors used are "deep chrome yellow" and "orange chrome yellow." They may be purchased at any artists' supply store. This work should be lacquered.

Green Gilding.—This is accomplished by first gilding the article in the Roman or fine gold solution; then take a small quantity of the gilding solution and add to it a little silver solution, not more than a spoonful at a time, until the desired shade of green is obtained. Do not have the green solution hot; better results will be obtained when only warm. Use a weak current and a small platinum anode, if convenient.

CHAPTER IX.

SILVER PLATING.

Silver plating is one of the most useful branches of the plating industry and perhaps the oldest process of practical commercial value. Considerable supplementary knowledge is required in silver plating on the different classes of work, such as table cutlery, Britannia ware, German silver or brass goods. When one has the necessary knowledge for handling these classes of work in detail, there is a certain enjoyment or fascination about it which makes the plater take much pride in his operations and justly so. But to have this serene, confident feeling one must be thoroughly master of the situation and understand both his solutions and the nature of the class of work which he is handling in its preparation for the bath. If the operator will become thoroughly conversant with these details, the rest will be comparatively easy.

SILVER PLATING ON STEEL.—This is one of the most difficult operations in the whole line of electroplating. The plating itself is easy enough. But to get the silver plate so that it will adhere to the steel when it is receiving the finishing polish under the steel burnisher is a different thing. This applies to all steel goods requiring silver plating and burnishing, but in particular to flat ware, steel knives and forks, etc., except the cheaper ones which will be treated later. This class of goods are all plated directly upon the steel and hand burnished. The burnishing gives the high polish required, closes up the pores in the plate and makes the silver very hard, thus increasing the life and usefulness of the article.

Knives and other steel goods to be silver plated, especially when new, should be washed in benzine to remove all grease and oil, then placed in an earthen dipping basket and put into a clean strong potash (crude potash is preferable) boiling hot for thirty minutes to one hour. Then remove to the scouring bench. Do not rinse, but let the hot potash dry upon the knives which will prevent rusting. Remove two or three at a time, as you wish to scour them. Scour very thoroughly with a revolving bristle brush, or hand brush, or both, using plenty of wet powdered pumice stone and a little cyanide of potash solution on your brush to facilitate the cleaning. When clean, rinse in cold running water; then place in a clean crock of water into which one pound of washing soda has been dissolved. Allow the knives to remain in this soda solution until all are cleaned and ready for the plating solution; this will prevent their rusting while the others are being cleaned. Where any large quantities are to be plated frames should be provided for holding the knives. Each frame should be made to hold six knives and should be in a circular shape, with a long copper wire soldered or riveted in the center, with a hook at its upper end to hook over the cathode or work rod. The holes in the frame should be large enough for the knife or fork to be dropped in, handle down, and to catch in the frame around the bolster. The knives in the frame, when being plated, should be moved from time to time so that all parts will be plated, especially where the bolster rests upon the frame; this may be done without taking them from the solution, by removing the frame from the rod and giving a quick jolt or jerk, while under the solution, which will change the position of the work which rests on the frame. Where there is not enough work to warrant using the frames and copper slinging wire is used the position of the wire should be changed upon the work once or twice while being plated; if not, it will leave a ring or mark around the bolster that will not be plated, or very lightly, to say the least, and is very liable to cause failing when it comes to be burnished.

The work being all thoroughly scoured it should now be removed from the soda, placed in the frames or wired quickly (only removing what can be handled with dispatch at one time), rinsed in clean cold water, dipped into an acid dip composed of one pint of muriatic acid to each gallon of water, rinsed again, and if water flows freely and evenly all over the work, hang it in the strike solution at once. If the water breaks away and withdraws from any one spot, it is a sure sign of dirt or grease, and it will be useless to proceed with the unclean article, as it must be cleaned again to prevent failing.

The work should be left in the strike solution only until it becomes whitened, or struck all over. Move the work gently while striking. From one to two minutes is usually sufficient, depending of course somewhat upon the condition of the solution and the amount of the current used. After the work is struck up, it is hung in the silver-plating bath immediately, without any rinsing.

The current must be reduced to the lowest possible point on the silver solution when beginning to load up the vat so that the first part of the batch of work will not burn while the remainder is being struck up. If the current cannot be sufficiently reduced to prevent burning some of the anodes may be hung upon the center rod while filling the tank and then put back into their proper places as the vat fills up.

The best quality of silver-plated flat ware is usually run from one and one-half to two hours in the solution, for twelve pennyweight goods. This standard meaning that they are supposed to have twelve pennyweights of silver to every dozen of knives. Some few firms making this class of goods live up to this rule, but a great many fall far short, giving their plater instructions to put on ten or perhaps only eight pennyweights to the dozen, yet the goods are stamped "12 dwt."

The standard by which the large plating factories in the East are governed is about as follows as to the amount of silver deposited.

Per Gross.	Double.	Triple.	Quadruple.
Table spoons	96 dwt	8 oz	12 oz.
Dessert spoons	72 dwt	6 oz	9 oz.
Tea spoons	4 dwt	4 oz	6 oz.
Knives and forks	72 dwt	6 oz	9 oz.

The proper way to determine the amount of silver to be deposited upon the goods is to weigh them just before putting them into the silver bath and then weigh again upon their removal after plating. For example, in plating steel knives that require ten pennyweights to the dozen, weigh a dozen or half dozen before plating; then when in the solution about one hour weigh again; then repeat at intervals until you have the required amount deposited. It will not be necessary to do this often, as you now know the amount of silver deposited in a given time, with a certain amount of current, provided the solution is not allowed to become deficient in metal and the anode surface must not be greatly reduced to get the same results.

Some large factories in the East have the cathode rod of the silver-plating vats attached to a weighing scale, which when the desired amount of silver is deposited gently raises the rod, work and all, from the plating bath, thus assuring an even and uniform weight on all goods handled.

Great care must be taken to prevent this class of work from burning, as this makes the blades rough, hard to burnish and very often causes the work to peel.

There are several schemes for gently moving the work to and fro, which prevents burning and causes the goods to take on a uniform and fine-grained deposit. This movement may be accomplished by attaching a long rod at one end to the cathode or work rod of the silver solution, the other end being attached by a crank pin to the side of a slowly revolving pulley arranged for the purpose. This apparatus is used extensively in flat ware shops, but not on Britannia or other similar goods. Flat ware, when removed from the solution, should be immediately dipped in very hot water and then swung in the air until dry. Then they are ready for scratch brushing or sanding. The latter is to be recommended, using white sea sand (wet) and rubbing each piece all over lengthwise until the white cast disappears. Then the sand should be thoroughly washed off and the work dried. It is then ready for the burnisher. Sand has several advantages over the scratch brush, where it is practical to use it, as it is on flat ware; first, it does not remove any of the plate and will leave the work clean and white, while the brush very often leaves it greasy and dull.

The careful and economical plater will always provide a rinsing tub, as close as possible to the silver bath. This should be filled with clean water and all work, upon being removed from the silver solution, should be rinsed in this tub, so as to wash off and save the solution adhering to the goods. This rinse water may be used to fill up the silver solution when necessary.

Silver plating baths may be made by using different quantities of silver, as little as one-half ounce to the gallon making a solution that will do fair work, but such solutions are not recommended, for if there is not sufficient silver in the solution it must come from the anode which is robbing Peter to pay Paul. The best silver solutions have three and even four ounces of silver to the gallon.

Some platers use a silver solution with the highest possible amount of silver per gallon which can be taken up and held in solution by cyanide of potash, making a very rich, expensive and extravagant solution from which the results obtained can be no better than from the standard solutions of about three ounces per gallon. Therefore it seems a needless expense to have several ounces of silver per gallon in a solution more than is absolutely necessary, as in a large solution of several hundred gallons it runs into money very fast.

A good standard solution consists of:

Chloride of silver	2½ oz.
C. P. cyanide of potash	12 oz.
Water	1 gal.

To prepare a silver bath, take the number of ounces of metallic silver you wish to put into your solution. It should be rolled or hammered thin, and heated to a red heat to soften it, and then cut into small bits or strips, so that it may be readily attacked by the acid.

In buying metallic silver to make new solutions it is best to buy granulated silver which comes in the form of small nuggets and is usually very pure. On account of the irregular form the acid attacks it readily and it is quickly reduced to nitrate, thus doing away with the necessity of rolling and cutting up as in the case of sheet silver. Then take a large necked bottle, or a jar, putting in it about six parts nitric acid to one part of water; set this bottle or jar containing the acid and water into a jar or tub of hot water; when the acid begins to get warm add the scraps of silver. If the acid is in a small vessel add the metal slowly, to prevent the acid from boiling over, as it attacks the silver. One pint of C. P. nitric acid and one-sixth pint of water will reduce about twenty ounces of silver. This cutting down of the silver should be done out of doors, or where there is good ventilation, as the acid fumes are very injurious to health if inhaled. This work should never be done in a room where there is machinery, tools or polished metal goods, as it causes all metal goods to rust or tarnish.

When the silver has all been reduced by the acid it is then nitrate of silver and should be diluted one-half its volume or more with water. Then a strong solution of table salt (chloride of sodium) must be prepared and added slowly to the nitrate solution, stirring with a glass rod. This will precipitate the silver to the bottom of the vessel in a white mass, which is chloride of silver. The salt solution should be added until the silver is all precipitated; then fill the vessel with hot water and allow to settle; or, if the vessel is already full, dump the contents into a larger clean crock, fill with clean, hot water, stir up and allow to settle. The idea in adding water is to reduce the specific gravity of the solution so that the fine silver precipitate will settle quickly. If this were not done it might take hours to settle. Pour off or syphon off the liquid, as soon as it is perfectly clear and fill up the jar with water. Repeat this several times, or until the salt cannot be tasted in the wash water when touched to the tongue. The last washings should be with clean cold water. Never remove the water entirely from the chloride, as it is readily attacked by the air and decomposed.

When the chloride has been thoroughly washed, dissolve the cyanide of potash in another vessel, pour the water off from the chloride of silver and add the solution of cyanide of potassium with stirring until the silver chloride is all dissolved and taken up by the cyanide. Then add a little excess of cyanide and the solution will be ready for work. Perfectly clean soft or distilled water should be used in making all solutions; distilled water is preferable where available, as the silver salts are very readily thrown down in metallic powder by impurities in the water. Silver solutions, unlike nickel, become better with age, provided they are kept clean and their strength in silver and proportions of cyanide of potash maintained.

STEEL STRIKE SOLUTION.—Some platers who plate flat ware exclusively, or extensively, use a special or steel strike, the difference from the regular silver strike being that the steel strike is much stronger in cyanide and weaker in silver than the silver strike. A carbon anode is used with it. This solution should stand from 20° B. to 24° B., and is composed as follows:

C. P. cyanide of potash	2 lbs.
Distilled water	1 gal.
Silver solution	½ pt.

Of course it all depends upon the quality and strength of the cyanide as to just how much will be required to bring the hydrometer up to the desired figure.

The steel strike is only used as a preliminary, the work, when the two strikes are used, being immediately immersed in the second or regular silver strike. The steel strike is not generally considered a necessity but as a convenience assuring a greater degree of success on steel work. It is used in the belief that it helps to prevent failing. This is, however, another question.

The regular strike, or whitening solution for steel work, is composed mostly of cyanide of potash and water (about two pounds of C. P. cyanide to each gallon of water) with the addition of about two quarts of silver solution to each five gallons of striking solution. It will be seen that very little silver is used in striking steel; if more were used, it would cause the work to fail or peel. The strike for steel should stand about 18° to 20° B. For an anode, if there is very little silver in the strike, two small silver anodes may be used. wired so as to conduct the current freely; but the best and surest results are obtained by using two small pieces of steel or carbon as anodes. In this way you plate directly from the solution, which will become exhausted in time. When used continually a little silver solution should be added once or twice a week. When using the steel for anodes, a small piece of silver may be wired with the steel and used as an anode. This will replace the silver drawn from the solution and the steel anodes may be large enough so that they will cause quicker and more powerful action, as speed is required in striking steel work. A considerable amount of current is advisable in striking, as this will cause the silver film deposited on the work while it is in the strike to adhere to the steel more readily, which is the prime object in striking.

In order to prevent the work from burning when striking it should be moved gently, with the hand, back and forth on the cathode rod and the work should only be allowed to remain in the strike long enough to become covered all over with a yellowish or whitish film of silver. From one to two minutes is long enough. It should then be hung directly in the silver plating bath without rinsing.

Both the silver solution and the strike must have separate and independent switchboards so that the current may be controlled at will, according to the amount of work at hand. Silver solution suitable for flat ware is composed as follows:

Chloride of silver	3 oz.
C. P. cyanide of potash	1 lb.
Rain water	1 gal.

All silver solutions should have a small excess of free cyanide to keep the anodes clean and bright (see free cyanide).

Cheap Flat Work.—There are several ways of handling cheap work, either when new or old. Many small dealers and job shops buy the steel blanks from a manufacturer and plate them. They are furnished already ground, polished and wrapped up one dozen in a package and are all ready for plating. Then there are "seconds," which may be had still cheaper, on account of the metal having some little flaw which would not make a perfect knife, yet for the cheaper goods it does very well. These goods may be bought with any name or stamp upon them which the purchaser may desire, provided they are taken in sufficiently large quantities. This class of goods is generally put out to sell, not to wear. It is generally sold cheaply, consequently there can be very little silver upon them, the object being to get as little silver on as possible, yet to get it on in such a way that it will take a high finish, appear to good advantage and look like the real "12 dwt." hand burnished goods.

The most approved way for handling this work is as follows: Prepare the work for the nickel solution. Give a light and even nickel plate all over, being careful that no wire marks remain unplated. Run about ten minutes in the nickel; then rinse off and hang in the duplex, or acid, copper solution, running in this about fifteen minutes to one-half an hour. When plated sufficiently, remove, dry thoroughly and buff, finishing in the best possible manner, for on this operation depends largely the appearance of the finished article. After being buffed clean (no rouge or grease should be left upon them), they are ready for nickeling again. If the goods come clean from the buff they may be wired and potashed in strong hot potash for two or three minutes or until they change color slightly, then rinsed in cold water, dipped in a cyanide of potash dip, rinsed again and hung in the bright nickel solution (see bright nickel) for about ten minutes with a very moderate current. This will give a very bright and hard surface upon which to deposit the silver, so that little polishing will be required when the article comes from the silver solution and consequently little silver is required, which is the main object in handling the work in this way. If the coppered goods are greasy and do not appear clean, of course, they will have to be brushed with a soft brush and potash to remove all grease and dirt before putting into the nickel bath.

When removed from the nickel the goods should be thoroughly rinsed in cold running water, then struck up in the silver strike (without any other preparatory dip) and then hung in the silver solution from fifteen to twenty minutes with a slow current. When removed and dried, they should have a bluish, pearly white cast and should buff up readily with soft rouge and alcohol, or soft rouge and kerosene.

The silver solution for this kind of work may be brightened, it only bright plating is to be done in it, but if heavy deposits are also required from the same solution it should not be brightened. Bright solutions will be described farther on.

Another way to handle this work is to first copper plate it in the cyanide of copper solution, getting a deposit which is sufficient to stand buffing and then plate the silver upon the copper, not using the nickel. In this way it requires more silver to stand the finishing buff and it is not as satisfactory as the previously described method, as silver on copper is not capable of taking so high a polish as silver on bright nickel and does not do it so readily. This class of work should never be allowed to lie around wet or damp, as it rusts very quickly, even after plating. It should be thoroughly dried when taken from the silver bath.

The cheapest method of handling steel knives to be silver plated, is to have them fairly bright when coming from the polisher, give them about ten minutes plate in a bright nickel solution with a very moderate current, so as not to burn the edges, then remove, rinse in clean cold water, strike up in the silver strike and run in the silver solution for about fifteen minutes with a low current. Then they should be removed and dried in very hot water and are ready for buffing.

BRITANNIA OR WHITE METAL.—Britannia, or white metal, as it is commonly called, is much more easily handled than steel work. If the proper dips are used and due care taken in cleaning the work, there should be very little trouble from failed work. In the silverware factories, or shops where considerable of this work is handled, the plating room is fitted up especially for it.

Where it is handled in great amounts, either new or old work to be replated, there should be two potash dips. The first one is for potashing the work after polishing and before cleaning with powdered pumice stone; the other is usually made from caustic soda. Its use will be explained farther on. The potash used for Britannia should not be used for other metals, on account of the lead contained in the Britannia; the potash becomes saturated with this lead and it is readily deposited upon other metals if they are placed in the potash and is sometimes very troublesome to remove, destroying the finish on the goods and requiring them to be repolished.

When the Britannia comes from the sand buffer, it is as a general rule washed out with strong soap suds or brushed out; using a small stick or wire to get greasy sand out of rivet holes, etc. Then it is ready for the potash. After remaining in the potash for five or ten minutes it is removed, rinsed, hung in cold water and thoroughly scoured, a piece at a time. A small lathe with quite a long spindle and taper at the end, running at a slow speed, should be located at or very near the scouring vat. Inside or goblet bristle brushes are used on this for cleaning and scouring the inside of the hollow ware, such as coffee and teapots, sugars, creamers, etc. Large circular bristle wheels may also be used to good advantage on the outside of the ware.

The use of the lathe is very general on account of its being much quicker than hand work. As a rule, the finishing touches should be put on with the hand brush while making a close inspection of the work. The work should then be rinsed and dipped in the quickening dip, sometimes called the blue dip, composed as follows:

Corrosive sublimate	1 lb.
Sal ammoniac	2 lb.
Water	6 gal.

Corrosive sublimate (bichloride of mercury) is very slightly soluble in cold water and sparingly soluble in hot water. The sal ammoniac (chloride of ammonium) is added simply to assist in dissolving the mercuric salt and to hold it in solution, as if the bichloride were dissolved to the fullest extent in hot water, a large portion of it would fall out of solution again as soon as the water became cold. It is better, therefore, to dissolve the sal ammoniac in hot water and then, keeping it hot, add the corrosive sublimate a little at a time with stirring until it is all dissolved. Then allow the solution to cool and pour off the clear solution into the jar which is to be used for the dip. In this way about five times as much mercury may be used as if it is made in the ordinary method of dissolving the ingredients separately in hot water and then stirring together. Care should be used not to get any of the sediment of corrosive sublimate in the dip, as it will make bad spots on the work. Another very good dip for Britannia ware consists of

Corrosive sublimate	1 lb.
Muriatic acid	1 pt.
Water	5 gal.

Dissolve the corrosive sublimate, add the water, then the muriatic acid. After the work has been dipped in the quickening dip for a moment or two, it will form a bluish film over the work. It should then be dipped immediately into the second lye or hot caustic soda dip previously mentioned without any rinsing in water. After the hot lye it is given a thorough rinsing in cold water and placed in the strike for one or two minutes, or just long enough to whiten evenly.

In plating hollow ware the anode rod should have attached to it a wire of suitable length, upon the other end of which is a strip of silver with which to strike or whiten the insides of such pieces as require it, such as coffee and tea pots, sugar bowls, and the like. While the work is in the strike, hold this piece of silver by the wire so that it will descend into the inside of the dish for a minute, being sure that you have a good clean connection with the anode rod before you start. The piece of silver must not be allowed to touch the piece of work while hanging in it. When this is done the work is ready to go directly into the silver bath.

All the larger hollow pieces, such as ice pitchers, coffee pots or urns should have a small anode hung inside the hollow article while plating. This is done by attaching the anode to a sufficiently long wire, the other end of which is made fast to the anode rod opposite where the hollow piece is to hang. Then take a piece of rubber hose two or three inches long, slit it up one side, spring it over the work rod just over where the hollow piece is which you wish to plate inside, then lay the wire with the anode attached over this rubber and let it hang down into the inside of the article, taking care not to let it touch, as wherever the anode touches it will burn the metal and make it rough.

Britannia ware is usually run from one and one-half to two hours where a quadruple plate is required, with proper conditions as to solution and current. When removed, it is rinsed in the rinsing tub previously described so as to save all the drippings from the solution; then it is rinsed again in cold and then in hot water and dried, preparatory to scratch brushing with the brass wire brush, or sanding, which is necessary before burnishing.

There is a false idea among people who do not know, but think they do, as to just what "single," "double," "triple" or "quadruple" plate means. The writer has had people who should know better insist that triple, or quadruple, plate means three or four separate plates; that the goods were plated once; then finished; then plated again and so on until the required number of plates were deposited. As a matter of fact, the goods are only plated once but the amount of silver is regulated by the time which the goods are left in the solution, condition of solution, amount of anode, surface and amount of current being used, all being factors which must be taken into consideration. A single plate usually requires about one-half hour under favorable conditions; double plate one hour, triple plate one and one-half hours; quadruple plate two hours. Of course, with a rich solution, plenty of anode surface and good steady current of proper force this time for the different plates may be reduced somewhat.

Silver anodes should be hung on iron wire or strips of Britannia metal, which will prevent them from falling into the solution.

Brass and German Silver.—These goods are handled much in the same way for silver plating as the Britannia except that they require even more care in preparing for the silver bath, especially German silver, which is a hard metal to make the plate adhere to firmly enough to withstand the pressure of the burnisher. A good dip for quickening brass or German silver goods before plating is made by putting an ounce of metallic mercury into a bottle and adding just enough nitric acid to dissolve the mercury. Every particle of the mercury must be dissolved, otherwise it will adhere to the work, if it comes in contact with it and prevent that particular part from plating. When thoroughly dissolved, you have nitrate of mercury. To this add two gallons of water and one pound of C. P. cyanide of potash and stir well. It is then ready for use.

Where brass or German silver goods are plated in connection with Britannia the quickening dip given for Britannia will answer very well for either brass or German silver, but the nitrate of mercury dip just given will not answer for quickening Britannia goods.

Handling Cheap Novelties.—There is a large class of work which merely requires the silver finish or color, without having any particular amount of silver deposited. This class includes cheap, brass novelty goods, which are lacquered after finishing, linings and reflectors for carriage lamps, coffin hardware and other similar goods. This class of work should be highly finished on the buff, leaving no traces of the rouge or buffing compound or finger marks upon the work. It is then wired and potashed in strong potash for a few moments; then rinsed and run through the cyanide dip; rinsed again and placed in a bright nickel solution with moderate current for ten to fifteen minutes. (See Bright Nickel.) The work is then removed from the bright nickel, rinsed in clean cold running water thoroughly, and then struck up in the silver strike immediately, without any other preparation than the thorough rinsing. Care must be taken not to leave these goods in the strike too long and not to have the current strong enough to burn the corners or projecting parts of the work; but enough current must be used to strike the work quickly, otherwise the silver may not stick well. After the work is struck up, place it immediately into the bright silver solution for from ten to twenty minutes.

Bright Silver Solution.—To make a bright solution, take from six to eight drops of bisulphide of carbon, place it into a quart bottle and fill the bottle nearly full of silver solution from your silver bath. Cork the bottle tightly and shake it vigorously several times during the day, or until all the carbon seems to be dissolved. Let it settle over night and then add about one tablespoonful of this mixture to each ten gallons of silver solution in the tank. Do the same thing with the strike solution. The carbon may also be dissolved by using alcohol, instead of solution, but in any case it must be all dissolved before using. This will brighten any silver solution. It also greatly reduces the amount of silver deposited in a given time, so that it is not advisable to brighten any silver solution by this process where heavy deposits are required from the same solution. This is recommended only for bright plating exclusively.

In using bisulphide of carbon for bright silver solution, it is absolutely necessary that the bisulphide of carbon should be thoroughly cut up by the silver solution in the bottle before being used, as if any bisulphide of carbon is left undissolved and gets in the solution in the tank it will turn the work black and will cause much difficulty before it can finally be removed. Ample time should be taken to dissolve the carbon by shaking the bottle many times thoroughly. When the solution has settled after being shaken sufficiently, it can be held up to the light; if any particles of the carbon remain they will appear like small oil bubbles in the bottom. In that case the bottle should be shaken again until all the particles of carbon disappear.

A bright plate of silver may be obtained without the addition of any brightening ingredients by simply reducing the current and the anode surface. It will also assist matters to have the solution quite strong in cyanide and low in silver.

Screws, washers, buttons, and other small articles may be bright plated in this way by using brass wire baskets of suitable size and mesh. Such work should be bright nickeled first and then handled like the work just described, except that in striking work in baskets, it takes somewhat longer and more current is required. The basket should be given a quick shake or jar from time to time, so that all parts may be exposed and struck up evenly. This should also be done when the basket is in the plating solution.

This small work, of iron or steel, is usually polished and cleaned before plating by rolling in a small barrel revolving at about forty-five degrees and making two hundred to three hundred revolutions per minute. By rolling in this way with enough soap powder and water to make a thick suds or lather, the work will be thoroughly cleaned and highly polished. It should then be dipped out as required and put in baskets, rinsed, potashed and proceeded with as with any other work. After plating some classes of work may be polished in the same manner.

THE MANAGEMENT OF SILVER SOLUTIONS.—I wish to say here that the operator should know that his silver solution will require the addition of chloride of silver from time to time, no matter what class of work he is engaged in, where the solution is run continually and large quantities of work are being plated. Chloride of silver should be added every week or ten days; using the thin anodes and scraps of silver to cut down and make the chloride for this purpose. Do not dump the chloride into the solution, but place it in a large pitcher or other handy vessel. Fill the pitcher with solution from your silver bath, stir up vigorously, let settle and pour the clear solution back into the silver bath. Repeat this operation until the chloride of silver is all dissolved. If the chloride is put directly into the solution some of it will remain undissolved and sink to the bottom of the tank, where it will do no good.

Cyanide of potash should be added to the silver solution at times, but not so frequently as silver.

I will now attempt to give the operator a few simple but very necessary directions to tell when his solution needs either silver or cyanide. Silver anodes, when suspended in the solution and not in use (that is, when nothing is being plated) should become white and bright if the solution is in a proper condition. If they remain dull, or of a dirty, dead color, it is a sure indication of the lack of free cyanide of potash in the solution. If the anodes turn a brown color when in use it indicates a lack of free cyanide and more should be added, as the work will plate slowly and unsatisfactorily when the solution gets in this state. Cyanide enough should be added, a little at a time, until the anodes do not take on the brown oxide when in use. When the silver solution becomes deficient in silver, which it does very easily, when being worked continually without frequent replenishing with chloride, the anode becomes black and coated over with a black oxide of silver, which will get so bad if the difficulty is not remedied by the addition of chloride of silver that it will leave the anode and become mixed through the solution in dark streaks. This may settle upon the articles being plated, but will in no way injure the deposit and will settle to the bottom of the tank during the night, when the solution is quiet.

All of the above conditions are the well-known signs by which the experienced plater is able to tell quickly just what the difficulty with the silver solution is and how to remedy it. There are many theories (but not among experienced silver platers, I think) as to what causes the different conditions at different times in the silver anodes, but a test will show that the rules herewith set forth are correct.

The proper color for the silver plating anode is white, or nearly so, with a possible shade of gray. If the plater will keep these rules in mind and make use of them as the occasion demands, he will have no difficulty in keeping his solution in a healthy condition.

Silver anodes should not be allowed to remain in the solution over night nor for any great length of time during the day when not in use, as the cyanide gradually attacks and dissolves the silver. When through using the solution remove the anodes, rinse in the silver rinse water, run them through hot water, so as to dry them quickly, and put carefully away, as on account of the roughened surface of the corroded metal they are difficult to clean, if allowed to get greasy or dirty. The anodes should, however, be allowed to remain in the solution long enough after plating ceases for them to take on the natural silver color, after which they may be removed and treated as above.

It is good practice for the plater to weigh his silver anodes at the beginning and close of each day's work. In this way he knows just how much silver he has used on a given amount of work and can more easily figure the cost of work.

Silver solutions, and, in fact, every other solution, should be filtered from time to time as the occasion requires.

STRIPPING SILVER PLATED GOODS BY THE ELECTRIC CURRENT.—In stripping steel goods that have been silver plated, such as knives, forks, etc., the cyanide strip is always used. This is composed of one pound of C. P. Cyanide of Potash to each gallon of water used, with the addition of one pound of caustic soda to a four or five gallon strip. The caustic soda is not necessary to make the strip, but it facilitates the work. The strip will be ready for work as soon as made. The current must be reversed for stripping, which is done by hanging an old file or other clean piece of steel into the strip attached to the cathode pole or rod. Then the work to be stripped is wired up upon iron wire and attached to the anode rod, as the action of the current would soon cut copper wire, letting the work drop to the bottom. Several pieces may be stripped at once, say a dozen of knives, but they should not be wired too closely together, and when stripping the work should be agitated and all parts should be exposed to the steel cathode. A strong current should be used and the work kept moving in the strip. In this way a large amount of work may be stripped in a very short time. If the strip, after being worked for some time, refuses to work as fast as at first, clean the silver from the cathode. Let it go to the bottom of the strip. It will not work well when the cathode is coated thickly with silver. When the strip is used continuously, it will be necessary to add a little cyanide from time to time to keep up its working strength.

Britannia ware or white metal may be stripped in this strip just as readily as steel and in the same manner, but it is not recommended for German silver or brass goods, especially the latter, which would be ruined by the action of the current, if not watched closely and kept agitated. German silver may be stripped in this way, provided it is not forgotten or left in the strip too long.

Acid Stripping Solutions.—The strip generally used for brass and German silver goods and which also works well on Britannia or white metal, is composed of sulphuric acid, to each gallon of which has been added one-half pound of salt petre (nitrate of potash). This strip must be used hot and without a current. The best method of heating is by setting the jar containing the strip into a tub of hot water where it can be kept hot while in use (see Dips and Pickles). This strip should be tightly covered, as it will be ruined if any water is allowed to get into it, so care should be taken to have the work dry before immersing it in this strip.

A very small quantity of nitric acid may be used in place of the saltpeter, say from four to eight ounces to each gallon of sulphuric acid. In case the nitric acid is used the work being stripped must be watched more closely and not allowed to remain in the strip any longer than is necessary, as the nitric acid causes the strip to work much more readily than does the saltpeter. The work should be immediately removed from the strip when all traces of silver have been dissolved from its surface.

To Recover Silver.—To recover the silver from the cyanide strip, it may be allowed to settle and the clear liquid drawn off; then the sediment may be washed, dried and sent to the refinery, melted down again, or reduced to chloride (see Chloride) and added to the solution. In removing the silver from an acid strip, it should be allowed to evaporate as much as possible and then be taken into the open air, water added to reduce the strength of the acid, and a solution of cyanide of potash slowly added with stirring to neutralize the acid and precipitate the silver. Then it can be washed and dried as in the other case. In doing this the plater should be careful to remember what has been said about adding water to acid in a previous chapter, as there is danger of its flying and burning the workman, if much strong acid is present in the strip.

Silver Plating Musical Instruments.—This is a special branch of plating that should be treated in detail because of the value of the instrument and the difficulty in plating and finishing it properly; also because of the great danger of spoiling the tone of the instrument or injuring its mechanical working.

The metal from which cornets and horns are made being very thin, and their construction quite delicate, it is a difficult matter to properly strip off the old plate, which it is necessary to do before replating them. So before stripping such goods remove all moveable parts, such as the valves. Have a quantity of assorted sizes of corks at hand with which all holes should be tightly corked; also cork the hole in the bell of the instrument to prevent the acid from entering the inside of the horn while in the strip.

A new strip, or at least one that there is positively no water in, should be used for stripping brass instruments and they should be left in the strip long enough to remove the old plate and no longer. This will usually be only a few minutes, if the strip is hot and in good working order. Next the instrument is removed, rinsed, the corks removed, and the instrument is again very thoroughly rinsed (the inside also) to remove any acid that may have worked in during stripping. Now dry it and proceed to polish.

The polishing is also difficult, on account of the danger of letting the instrument get caught in the wheel, which is apt to bend or break it. For this reason it is best to use small wheels on a rather small lathe. Polish as any ordinary brass work, but with more care and a more gentle pressure, to prevent denting.

Now it should be potashed a few minutes and then thoroughly scoured, using fine pumice and small brushes, sticks and rags to get in where the brush will not reach. After the scouring is thoroughly done rinse well inside and out, fill with clean water so that it will not float in the solution and again cork up tightly. Now it may be brushed over again; then run through the white dip and struck up. But the surest way is to run it through the bright acid dip, composed of:

Sulphuric Acid	2 qts.
Nitric Acid	1 qt.
Salt	½ oz.

That is, after it is cleaned, filled with water and corked up; the dip into the acid must be very quickly done and the instrument immediately well rinsed, run through the mercury, or white dip and then struck up.

An old and weak bright dip is the best to run the instrument through, as the new dip takes hold with too much vigor and makes the work rough, while the old dip, not being so powerful, works slower and with a more even and better effect. This dipping before plating is called "biting up."

If the instruments to be plated are not tightly corked before plating they are sure to receive more or less deposit on the inside, which will cause the valves to work hard, or refuse to work at all. Too much plating upon the inside of the horn is liable to affect the tone of the instrument After plating the water is removed, usually into the silver rinse water. Then the horn is rubbed all over with wet sand (not scratch brushed) which gives it a much whiter and cleaner appearance than would scratch brushing. It is now finished unless it is to be burnished, all over or in part.

The bell of a horn is gilded by inserting a cork in the neck of the bell, filling with gilding solution and proceeding as in gilding a cup or dish. To get the bright burnished effect, burnish the bell first, then rinse out with lye and gild once, not leaving the solution in the bell more than two to four minutes, which will give a beautiful, bright deposit not requiring any other finishing.

Silvering the Inside of Tubes.—It is sometimes necessary to silver plate the inside of brass or copper tubes, such as those employed by medical men and others. For this purpose, clean the work well by drawing a wet rag attached to a string, and well saturated with pumice, back and forth through the tubes until cleaned; rinse and then draw a rag through, saturated with the white dip; now attach a long wire to the anode rod and to the other end a small sponge, soaked with silver solution. Attach the tube by a wire to the cathode rod and draw the sponge through several times. Be sure that the wire on the sponge does not come in contact with the tube. Finish with sand on a rag.

THE APPEARANCE OF SILVER WORK.—The experienced plater can tell at a glance, from the looks of his work, whether it is plating as it should. When the work begins to plate it has a bluish white cast, which changes into a pearly white and as the operation proceeds and the deposit becomes thicker changes to a pure plaster-like whiteness, which becomes more dense in color as the deposit thickens.

CYANIDE OF SILVER SOLUTIONS.—What particular advantage cyanide of silver solutions have over chloride solutions, is a question not thoroughly settled, though it is a fact that each method of obtaining the same end has its supporters.

To prepare a cyanide of silver bath, proceed to reduce the metallic silver to nitrate as described for chloride. When the silver is all reduced, evaporate the acid as much as possible, leaving the nitrate of silver. Now add four or five times its volume in clean distilled water, to the nitrate. When the nitrate is dissolved, precipitate this by slowly adding prussic acid (hydrocyanic acid) while stirring the whole with a glass rod. Add the prussic acid until no more precipitate is formed. Allow the precipitate to settle and pour off the fluid, taking up the resultant cyanide of silver with cyanide of potash, the same as you would do with chloride of silver, except that so much cyanide will not be required. Or, after the silver is all precipitated it may be filtered and the silver taken up as before. To determine whether all the silver is precipitated, add a few drops of prussic or hydrocyanic acid to the filtered liquid. If no sediment is formed, there is no silver left in the solution. This operation should be conducted out of doors, or under a hood, or in a chimney place, as the fumes are very injurious if inhaled. A dilute solution of cyanide of potash may be used in place of the prussic acid, by adding the cyanide solution until no more precipitate is formed. Do not add cyanide in excess, as in that case some of the silver would be redissolved.

FREE CYANIDE IN PLATING SOLUTIONS.—"Free Cyanide" means that after just enough cyanide of potash is used to take up a given quantity of metallic salts and hold them in solution any additional cyanide is in excess and this excess is called free cyanide. All cyanide solutions should contain a certain amount of free cyanide which, when the solution is not in use will cause the anodes to take on their natural, bright, metallic color by dissolving the oxides formed upon the anodes during the plating process. If free cyanide is not present in sufficient quantities to accomplish this end, the oxides will remain on the anodes, obstructing the plating operations and eventually preventing any deposit whatever until the anodes are removed from the solution and their surfaces cleansed by brushing. This rule holds good with all cyanide solutions, especially those of brass, copper and bronze, as well as with silver. Care must be taken not to add too much free cyanide; in that case it makes the deposit hard and brittle. If the free cyanide is very much in excess it may prevent the formation of any deposit on the cathode, which will come from the solution as it went in. In that case more metallic salts must be added to reduce the amount of surplus cyanide. This should be accomplished with the cathode in the solution and a weak current on, so as to determine when enough metal has been added to make the solution deposit properly.

There is another way of adding cyanide to a bath which is practiced on large solutions by platers with a knowledge of chemistry, or who have had a chemist figure out certain reactions and proportions for them. This is the addition of hydrocyanic acid to the solution, instead of a cyanide of potash, whenever the lack of cyanogen is indicated in the solution.

We do not recommend this practice as a matter of general application for the reason that it is easy to get in too much, particularly in small solutions, and also because hydrocyanic acid is dangerous to keep around, unless handled by those who know what they are doing. The fumes of cyanogen gas will arise from the acid whenever it is uncovered and such fumes are at least fifteen times the volume and strength of those coming from cyanide of potassium, either dry or dissolved, so that platers who have trouble from handling cyanide of potash should let hydrocyanic acid entirely alone, or at best take great care never to inhale its fumes. Still the process has certain attractions, from a theoretical and chemical standpoint, which frequently induces its use and as it is frequently sold to platers as a great secret, we give the entire theory so that those unacquainted with chemistry may fully understand it.

Cyanogen is a gas, easily separated from most of its compounds, particularly in the presence of heat. To the fact that it forms unstable compounds is due its extensive use in plating solutions.

When associated with potash it is called cyanide of potash and as such is well known to every plater. In the solution it leaves the potash and attacks the oxides of metals formed on the anodes, forming cyanates of these metals, which then flow to the cathode and are decomposed by being robbed of their metals. This cycle of operations is continuous. We thus see that there is in a working solution a constant setting free of cyanogen gas, which is partly held in solution by the potash and partly allowed to escape into the air, where it forms the well-known odor of cyanide, common to every plating room. In the course of time so much cyanogen has been allowed to escape into the air that we then have a complex condition of the bath, which consists of cyanates of the metal, held in solution by cyanide of potash, and also potassium hydrate, or caustic potash, which was left in the solution when the cyanogen evaporated. When this reaches a stage at which no free cyanogen is left to attack the metallic oxides on the anodes, no metal is dissolved and well-known troubles occur, which we need not take time to specify here.

Now right here is the difference in the two methods of supplying the needed amount of cyanogen. The plater simply adds more cyanide of potash and allows that to be decomposed also, relying upon the steady removal of solution on the work to eventually dispose of the excess of caustic potash which keeps accumulating in the solution.

The chemist claims to get better results by making up the loss of cyanogen by evaporation as a gas by the addition of cyanogen in the highly concentrated form of hydrocyanic acid, maintaining that the cyanogen so introduced will recombine with the caustic potash left in the solution and again form cyanide of potash, thus restoring the solution to its original constitution.

This is all there is to the great question of the use of hydrocyanic acid. If solutions are large and old, so that they contain a great deal of caustic potash, the addition of cyanogen in this concentrated form will clean them up and reinvigorate them to a wonderful degree. If the plater always knew how much caustic potash he had in his solution it would be the ideal way of adding cyanogen; but the trouble is that he does not know and is liable to overdo the matter, particularly in a small solution.

If it is decided to use this method on an old solution, add a few drops at a time to some silver solution in a pitcher, stir well and return the solution to the tank and then stir the solution in the tank. By proceeding cautiously, each night, the solution will have all night in which to absorb the gas and reform the cyanide of potash. If too much has been put in, the indications of too much cyanide will be the same as already set forth elsewhere in this book. This method applies to all cyanide solutions in which potash is used.

Silver Plating Without a Battery.—Silver plating may be accomplished without the use of dynamos or battery, but is not to be recommended except in cases of emergency. The first way is to take the article to be plated after properly cleaning; attach to one end of a copper wire about one foot long; bend the wire in U-shape. Attach to the other end a small piece of sheet zinc. Immerse both the zinc and work to be plated into the solution. This sets up electro-chemical action which will give a deposit of silver upon the object to be plated. Then it is to be finished in the ordinary way. The great drawback to this process is the fact that the silver is also deposited upon the zinc.

For plating with silver all small cheap novelty goods made of copper, brass, or German silver, the articles should be placed in a stone ware crock or dipping basket, potashed, run through the bright dipping acid two or three times if necessary to get them perfectly clean and bright. The work must be of uniform brightness, not being spotted or discolored in patches. Now have a jar of the ordinary silver plating solution, large enough to receive the dipping crock sitting in the hot water tank (to heat it). It works best and quickest when as hot as the boiling water will make it. Dip the work quickly, shaking the dipping crock if the work be flat and inclined to lie close together, so that all parts may be dipped bright. Rinse quickly and abundantly in clean cold water, then give a quick dip in the hot silver solution, shaking vigorously so as to plate all parts evenly. Let drain a moment, then rinse in cold, then hot water and dry in hot clean sawdust. Work not suitable or too large for dipping crocks or baskets may be wired on copper wire and plated in the same manner. This process will work very well also by using the silver solution cold. This class of work should be handled very rapidly.

Another method for silvering larger articles, or for cleaning or resilvering articles already plated:

Chloride of Silver	2 parts.
Cream of Tartar	2 parts.

Water to make this paste.

(To make the chloride see Silver Solution.) Mix well and apply with rag or sponge.

Another formula to be applied as above:

Cyanide of Silver solution (rich)	2 oz.
Whitening	1 oz.

Put both in a bottle and shake well before using.

CHAPTER X.

NICKEL PLATING.

It was the prevailing opinion among the older platers a few years ago that plating solutions, especially nickel, were affected by the atmospheric conditions. It was supposed that for some unaccountable reason solutions would not work well on cloudy days, so when the plater had a batch of poor or failed work on such days, it was very convenient to lay it to the weather. Another fallacy was that the sun's rays across a solution prevented the objects hanging directly in the sun's rays from being plated as readily as those not so affected. But all these theories have been exploded long ago and now when the operator has trouble with his work he must shift about for a more plausible excuse.

NICKEL PLATING ON BRASS, BRONZE OR COPPER GOODS.—If ever the motto, "Cleanliness is next to godliness," was applicable to one line of work more than another, the preparation of work for the plating bath is that line. Too much care and pains cannot be taken in the preparation and examination of work just before going into the plating bath. When properly and thoroughly cleaned, the most difficult part of the operation has been accomplished. Work to be plated should never be allowed to enter the plating bath until absolutely clean.

It is easier to plate ten or twenty pieces of new work that have never been plated before than to replate one piece that has been blistered or failed. There is very little satisfaction in doing work over; it seems like throwing money away. That is why particular stress is laid upon this one point of cleanliness and careful examination before plating. The old operator has learned this fact by a very costly experience, but the lesson has been well learned; consequently he will not try to plate an object that is not chemically as well as mechanically clean, and thus save himself much unnecessary work and some worry. It will be much better for the young man to learn this lesson from the experience of others and preserve his peace of mind. What is meant by chemically clean is to have the article when ready for the plating bath so that the clean rinsing water will flow evenly all over the article. If the water breaks and draws away from any part of the object it is a sure indication that it is not clean and it must be cleaned again. This rule applies to all kinds of metal; also to all kinds of plating.

Polished brass goods should come from the finishing buff as clean as possible; that is, without the tripoli, rouge or other buffing compounds being left in corners, crevices and chased or rough parts of the work. The expert and skillful buffer can avoid this by using a little care, and it greatly facilitates the work for the plater, allowing him to handle greater quantities of work in a given time, do it easier and turn out much better work.

When properly polished, small brass or bronze work only needs to be wired upon suitable wire so that the pieces will not touch each other. The wires must not be long enough to reach to or lie on the bottom of the plating vat. When strung on wires of even length they may be taken a dozen or more wires at a time and the work swished up and down in the hot potash, which should be near to the boiling point, but not boiling. When the work changes color slightly, immerse in cold running water, then for a few seconds into a cyanide dip, composed of C. P. cyanide of potash one pound to each gallon of water. Then put it back into the clean running water, rinse thoroughly and hang into the nickel solution immediately, as the air will cause the goods to oxidize if allowed to remain exposed even a few minutes, and this will cause the plate to strip, or peel off.

Small goods handled in bunches on wires may be held under the surface of the solution with one hand, while being fastened to the cathode or plating rod with the other.

Work that does not come clean from the buffing room will have to be potashed as just described, then well brushed with a soft brush and potash, or with whiting or Vienna lime, to remove the dirt and grease after it has been loosened by the hot potash. Then it should be rinsed in the potash again, then in water followed by the cyanide dip and water as before.

Rough castings and matted pieces of brass or bronze should be dipped in a bright acid dip before polishing, if there are any parts to be polished, then thoroughly potashed and handled as above described.

The plater should be very careful not to allow the pieces of work to touch or lap over each other when wired up to be plated. If this happens the covered or shaded parts of the work will receive a thin and inferior deposit of a dark cast. If the solution is not in first-class condition from any cause, the shaded or covered parts may not receive any deposit whatever. Large and heavy pieces of brass or bronze should have suitable hanging wires, or hooks of copper, so that a sufficient amount of current may pass freely through them. If small wires are used on large and heavy work they cause too much resistance and are very liable to burn and break. It also takes a much longer time to get the required deposit than it does when sufficiently large wires are used.

All objects in the nickel solution should be hung just far enough apart on the cathode rods so that they will not touch, and should be plated with as large a quantity of current as can be used without burning the work on the edges or projecting parts.

The very best results in nickel plating are obtained by running the work a long time, say from a half-hour to an hour, with a moderately weak current rather than using an intense current and a much shorter time. The plate that is forced on in a short time with a strong current is porous and brittle, is harder to polish and more liable to peel off.

It is a good plan before beginning to hang in the work in the nickel solution to hang an anode on the cathode rod at the point at which the current first enters the vat from the anodes used in feeding the solution. This will catch the brunt of the current and reduce its volume, thus preventing the work from burning. Before beginning to fill the tank with work the current should be reduced to the weakest point by the use of the rheostat or switchboard, with which each plating vat should be supplied. Very often the current cannot be reduced sufficiently in this way; hence, the use of the anode at the end of the tub on the center rod. Very often the operator has only a small amount of work to be plated (not enough to fill the vat), when the use of two anodes on the cathode rod, one at each end, with the work between them, will be found very convenient.

Under ordinary conditions and with a moderate current the anode surface should be equal to the surface of the batch of work being plated, this will usually give a uniform deposit. If the anode surface is much greater than the surface of the work being plated and the current cannot be cut down sufficiently by the rheostat, it causes the work to plate too rapidly, thereby burning, hence the use of the anodes at either end of the tub on the center rod. On the other hand, if there is insufficient surface of the anodes in the vat for the amount of work being plated the solution will be robbed of its metal and the deposit will soon have an inferior bluish cast. The work should never be allowed to hang too close to the anodes, six to eight inches being a satisfactory distance on most work.

A good nickel solution for plating all ordinary brass and copper articles where a good white and heavy deposit is required is composed of the following: About nine ounces of double sulphate of nickel and ammonia salts to each gallon of water. To every fifty gallons of nickel solution add eight ounces of boracic acid. This has a tendency to give the plate a snowy white appearance.

Another very good solution is composed of nine ounces of the double sulphate of nickel and ammonia salts to each gallon of water and from eight to sixteen ounces of granulated sal ammoniac (chloride of ammonium) to each fifty gallons of solution. Sal ammoniac in a nickel solution causes it to be a better conductor of electricity, thus causing it to plate more rapidly.

The general standard for nickel plating solutions is 7° B. Some platers prefer to have their solutions rich in metal and stand above 7° B.; others get better results from a weaker solution, one standing 6° B., or even as low as 5° B. In the writer's experience with all classes and kinds of nickel solutions he has had the most satisfactory and uniform results with solution that stands from 5½° B. to 6° B. on the hydrometer. Solutions that stand above 7° B. on the hydrometer are very apt to be too dense, often giving a dark and at times even a black deposit, and finally no deposit at all. This state of affairs may be remedied by drawing off part of the solution and adding cold water, thus reducing its density.

THE SOLUTION.—The double salt should be purchased of a dealer in platers' supplies, and care should be taken to get it pure and to use as pure water as possible. The salt is dissolved by boiling nine to fifteen ounces of the salts per gallon of water in a stone jar which has never been used for anything else, and filling up the bath with water until a hydrometer placed in it stands at 6½° B. to 7° B. This is the method followed for a small bath.

For a large bath this operation would take a couple of days and is not to be thought of, on account of the stoppage of the work for so long a time. Large baths are made by attaching a hose to a live steam pipe and putting a pipe with a steam valve on it on the other end of the hose, so that the steam may be readily controlled. Fill your vat about half full of cold water. Then take a large stone jar, perfectly clean and large enough to hold several gallons, put a large quantity of double sulphate into the jar, filling it perhaps half full; then add some cold water. Next turn on the steam, open the valve and allow the live steam to blow through a little to take out all dirt, oil, etc., that may be in the pipe; then shut the steam off, put the pipe in the jar and open the valve slightly, so that the steam enters and dissolves the salts, which it does very rapidly. Dip out the heavy solution as fast as it fills the jar and add it to the water in the tank, stirring vigorously after each addition of salt, until the solution stands at 6½° B. to 7° B. A workman can dissolve a hundred pounds of salt and get a large solution ready in an hour in this way, when it would take all day, or even longer, to boil and make the solution as first described.

BRIGHT NICKELING.—Bright nickeling is the process of plating all small brass or copper goods so that they require no polishing or finishing after coming from the plating bath. This solution is used mostly where small goods are handled that require to be plated cheaply, at the same time having a high finish and a durable plate. Several kinds of work requiring to be bright plated may be handled in baskets made of brass or iron netting with a suitable mesh, according to the size of the work to be handled. Brass wire netting or screen is best to make baskets for this purpose, as it causes less resistance of the current than iron netting. All small objects, such as screws, washers, etc., may be readily plated in this manner by covering the bottoms of the baskets evenly with the work to be plated, after it has been highly polished, then running the work through the cleansing solutions as any ordinary work. The baskets should then be placed in the solution with a moderate current and allowed to run from fifteen minutes to half an hour. The baskets should be shaken two or three times during the process of plating, to move the work, so that all parts may be exposed and receive an even, uniform plate. When the work has been sufficiently plated remove, rinse in cold water, then in boiling hot water and dry immediately in hardwood sawdust. Any small objects may be plated in this way, whether strung on wires or plated in baskets. Where the wires are used the work should be hung quite closely together in the plating solution and a weak current used to prevent the work from losing its brilliancy and taking on that snowy white cast which requires buffing. It must be borne in mind, however, that any object to be taken from a solution bright, and having a high polish must be bright and have a high polish when it enters the solution. Solutions for bright nickeling may be made the same as the foregoing nickel solutions, except that they should not stand more than 5½° or 6° B. on the hydrometer and to every fifty gallons of solution should be added one pound of single nickel salts (sulphate of nickel). This gives the brightness to the solutions.

The operator, in making up nickel or any other solutions, will be required to use some judgment in regard to the chemicals he uses, as sometimes stated amounts will fail to produce required or expected results, the reason being that one very often, through ignorance or by mistake, buys inferior, old or adulterated chemicals. For that reason it sometimes requires double the amount of certain ingredients in a formula to get the desired results. If quantities are weighed and some of the chemicals are so dry that they have lost their water of crystallization, you will get more metal in a given weight. Therefore it is always better and cheaper to buy materials and chemicals from a reputable house that makes a specialty of this class of goods. Where there are two or three different grades of platers' supplies, it is generally false economy to buy the cheaper goods, as in order to get good results in the plating, one needs the best of everything. The best quality gives the most satisfaction and generally proves the cheapest in the long run. The remarks on the purchase and storage of supplies in a previous chapter should be borne in mind.

NICKEL PLATING ON IRON AND STEEL.—Iron and steel goods usually require more work in the preparation for the plating bath than brass goods and usually require a longer time to plate, as such goods are generally given a very heavy deposit. Cheap iron goods may be plated directly on the iron or steel, but the better class of work is usually copper plated, either in a cyanide or duplex copper solution (see copper plating) after coming from the polisher. It is buffed after the copper plate and then treated like other copper or brass goods in preparing for the nickel solution.

Iron castings that are to be nickel plated should be thoroughly pickled (see pickles) to remove all sand and scales before going to the polishing room. After polishing they should be potashed in very strong potash, then rinsed, dipped in a cyanide dip and scoured thoroughly with powdered pumice stone. After scouring they are rinsed thoroughly in clean water, immersed for a moment in a dip composed of one gallon of muriatic acid to five gallons of water, rinsed again in clean water and hung in the nickel solution immediately. A great many platers use the cyanide dip as the last dip, just before rinsing and plating, for iron and steel as well as brass; this is a mistake, as one can readily see by passing the hand over the work just as it comes from the cyanide dip, or after it has been rinsed in clean water. The object so treated will be slippery, or slimy, and this is not the best kind of a surface to receive the plate. This is the cause of much of the peeling and failing of nickel work on steel and iron. On the other hand if the work after being thoroughly cleaned is passed through the muriatic dip, then rinsed in clean water, it will be found to have an adhesive touch, thus giving the nickel a much better surface to adhere to. It will be found if this plan is tried that there will rarely, if ever, be any work to do over on account of blistering or peeling.

Nickel on Tin, Lead, Brittania and Other Soft Metals.—Nickel may be plated directly upon all these metals except zinc; this plating would be of no commercial value unless the object is first copper plated and put in shape to take a high finish. Articles made from the above named metals requiring to be nickel plated must first be suitably polished (see Polishing), then given a heavy deposit of copper, after which they should be buffed up bright and nickel plated like other brass and copper goods.

In preparing these inferior metals for plating, care must be taken not to scratch or remove the finish and they should not be allowed to oxidize or to remain too long in the potash. This class of work, when wired up, should be held in the hand, swished in the potash for a few seconds, then cleaned with a soft brush and whiting, or Vienna lime, ready for the copper solution. This class of work, especially lead articles, should be given a heavy coat of copper, as lead and its alloys have a tendency to absorb the copper plate. A light copper plate upon a piece of lead pipe or other object will disappear in about twenty-four hours.

It must be remembered by the operator that the object being plated will receive only a certain amount or thickness of nickel, as it is deposited under a molecular tension. After it has received this certain amount the strains set up in the nickel will be greater than its adhesion to the work and the plate will begin to curl up and peel off in layers, thus ruining the plate and requiring it to be refinished and replated.

There is no fixed rule as to just when this occurs. With a strong current and a good solution it may occur in a half hour's time; with a weaker solution and weaker current the work may often be run as much as two hours with safety.

The operator will be obliged to regulate this condition according to the class of work being handled, the condition of his solution and the plate required.

Nickel being in itself a greasy metal, therefore it is difficult to get the greasy surface clean enough to plate nickel upon nickel and secure an adhesive result; it may be done, however, where the old nickel cannot be or is very hard to be removed, by paying special attention to the cleaning of the nickel object to be replated. It should be cleaned with strong cyanide and whiting or Vienna lime, and then rinsed in clean cold water. If the water flows freely all over the article it may be immersed immediately in the nickel solution and plated with a weak current, for not more than ten or fifteen minutes. It is useless to attempt to get a heavy deposit upon old nickel, as it invariably peels off if any great amount is deposited.

STRIPPING NICKEL.—This strip or dip should be put in an earthen jar with an earthen cover and kept tightly covered when not in use. When being used it should be placed in the open air or where there is a good draft to carry away the acid fumes.

The mixture is as follows: Three parts sulphuric acid, two parts nitric acid. This is for stripping the nickel from brass, copper or bronze goods only.

The work should be wired and thoroughly potashed, swung in the air until dry, then placed directly in the stripping solution without rinsing. It should be held in the hand and moved around in the strip for a few minutes then removed and rinsed thoroughly in cold running water, then in hot water. If the nickel is not all removed, the work should be potashed again and the operation repeated. This stripping process may be hastened by the addition of a small quantity of water to the strip, but care must be taken in this case not to allow the work to remain in the strip too long, as it readily attacks the brass surface when water is present, leaving it rough and spongy.

To remove the nickel plate from iron or steel goods it is necessary to remove the plate by polishing with felt or canvas wheels, set up with 120 or 150 emery and finished as other polished goods. There are no chemical solutions known to the writer that can be recommended for the removing of old nickel from iron or steel, hence we must have recourse to the polishing wheel.

Where a very high class of work is required in nickel plating and there is any doubt as to the purity of the anodes, it is a very good plan to have cotton bags or sacks made to fit the anodes. Each anode may be inserted in such a bag before it is placed in the solution. The bags should have puckering strings to be drawn tightly around the top of the anode. Where these bags are used it will prevent any foreign substances or alloys that may be in the anodes from getting in the solution or on the work to be plated. It is claimed for this process by those who have used it that it is possible to get much superior results in color and deposit.

THE DOCTOR OR SPONGE.—This is a very handy and useful little device for patching or plating spots which have worn off, been buffed through, or peeled up, when it is not convenient or desirable to replate the whole object. The doctor is made by taking a thin strip of nickel, say five or six inches long by one-half inch wide. If the nickel cannot be had, a strip of brass or copper may be used by first plating it heavily with nickel. Then put a small piece of sponge over one end, binding it tightly with a cord, and drill a small hole in the other end. Attach tightly to this a thin copper wire, two or three feet long, and fasten the other end of the wire securely to the positive or anode rod at one end of the plating vat. When about to use the doctor let it hang in the solution so that the sponge will become saturated with solution and soft. Then, after cleaning the object to be doctored, place it upon the negative or cathode rod, making sure to have a good connection between the object to be treated and the rod upon which it rests. Hold the object with one hand and the doctor or sponge in the other. Apply this saturated sponge gently to the part to be plated, moving it back and forth. Do not let it rest in one place, as this will blacken the spot. A weak current should be used for this operation, but it should be strong enough to deposit the metal readily. The sponge should be kept wet by frequently dipping it in the solution.

This is of great value, especially where large pieces have been plated, finished and found to have failed, or been cut through by the finishing buff in one or two small places. It can be readily patched up, thus saving the time and expense of replating the whole object.

THE CARE OF NICKEL SOLUTIONS.—When the nickel solution is working properly it will give off gas bubbles from the work being plated and these bubbles may form a whitish scum about the wires, especially where the work is plated for a considerable time with a strong current.

Nickel solutions used solely for plating brass, bronze and copper goods have a tendency to become alkaline. This is owing to the fact that the work is usually dipped in the cyanide dip just before being rinsed and hung in the plating vat. Very often the cyanide is not thoroughly rinsed from the work; especially is this true where the work being plated is hollow or has deep depressions. Where this class of work is being handled the solution is readily reduced to an alkaline condition if great care is not observed in rinsing the work for plating.

In solutions used exclusively for plating iron and steel directly (without the use of the copper plate) the opposite condition usually happens, that is, the solution becomes too acid. This is caused from the fact that the iron or steel work is usually pickled to remove the sand or scale and a portion of the acid remains in the pores of the metal. When placed in the solution the action of the current causes the acid to ooze out, thus, after a time, rendering the solution acid.

Nickel solutions are tested as to their density or richness by the use of the hydrometer, by which means we get the specific gravity. Each solution has its standard. Thus, a nickel solution is standard for ordinary work at 7° B., and every other solution has its proper standard according to the class of work for which it is required. The ordinary nickel solution standing at 7° B. would be unsatisfactory if used with the revolving baskets described in another chapter. Solutions for the latter work must stand from 25° B. to 30° B.

Nickel solutions should be slightly acid to obtain the best results, especially on iron or steel work. Red and blue litmus paper are used for testing the solution in order to determine this point. If we dip red litmus paper into the solution and the paper turns blue at once it indicates too much alkali; if the blue paper immediately turns red, it indicates too much acid. If the action is slower, it indicates a less degree of acidity or alkalinity. If neither red nor blue litmus is discolored the bath is neutral. If the bath is alkaline, double nickel salts should be added as a ready means of correction. If the solution has sufficient salts already and it is not desired to add more, a very small quantity of muriatic or sulphuric acid may be added. This will neutralize the alkali and give a white deposit of nickel on the work. Great care should be observed not to get too much acid in the solution; an ounce or two will be generally sufficient for ten to twenty gallons, and the solution should be stirred and time given for the acid to diffuse before testing again or adding more acid. Care must be taken not to use too much single salts, as it has a tendency to cause the plate to peel where a heavy deposit is required. It also makes the deposit hard and brittle. The acid in a solution may also be neutralized by using several ounces of bicarbonate of soda, dissolved in water and stirred into the solution. Or it may be powdered finely, stirred into the solution thoroughly and allowed to settle over night. This will get the desired result and will not harm the solution.

Liquid ammonia is also very useful in neutralizing the excess acid in a solution.

Sometimes the solution becomes too dense on account of the constant removal of water, which adheres to the work as it is removed from the tank. When the solution is too dense the anodes will be covered with crystallized nickel salts. When this occurs it will be impossible to get a good deposit, and if the anodes are allowed to be completely covered with these crystals, no deposit at all will be obtainable because the metal anodes are insulated from the solution, the crystals being a non-conductor of electricity. To remove the crystallized salts, the anodes should be placed in a jar containing clean boiling water, when the salts will be readily dissolved from the anodes. The salts dissolved in this water are then added to the nickel solution.

When the nickel baths are being worked very hard for a long period of time they sometimes become depleted of their metal. When this occurs they should be built up by the addition of double (sulphate of nickel and ammonia) salts, which may be dissolved in boiling water and added to the solution, or tied up in cotton cloth, or put into perforated earthen dipping baskets and hung into the solution over night. If it is required to add any considerable amount of salts to the solution this latter process will be found too slow, and the boiling water or the live steam pipe should be resorted to.

Long objects hung vertically should be turned after being coated about half the desired thickness, as the nickeling is always heavier at the bottom of a deep solution; for this reason it is better to hang the work with its greatest dimensions horizontal when possible.

Nickeling objects which are longer than the plating tank is a problem which the plater very often has to solve in plating such things as brass rods, flush pipes, rails and other long objects. It must be done properly at the first attempt, because the failure on such a job would cost more than the job would be worth. When the object to be plated is longer than the vat it should be thoroughly cleaned a little more than half its length. When ready for the solution a long hook or wire of suitable thickness should be attached to the clean end. This end should be lowered in one end of the solution nearly to the bottom, but not allowed to touch; the other end is allowed to rest on the edge of the opposite end of the vat, being bound to the center rod by a wire to insure perfect connection. As soon as the rod is thoroughly connected a basin of cold clean water should be poured upon the object being plated, just where it protrudes from the solution. This should be repeated once or twice while the object is being plated. When sufficiently plated it should be removed from the solution, the plated end being rinsed and dried. Then the other end should be treated similarly, seeing that the part where the joint is to be made is thoroughly cleaned. This time it should be cleaned a foot above where the joint is to be made on the part already nickeled and then proceed as before.

Nickel solutions should never be allowed to freeze, or come very near a freezing point, as the cold has a tendency to precipitate the salts in the solution. When salts have crystallized out of a solution in this way they will be found in the tank at the bottom of the solution and they will have to be removed, redissolved, and added to the solution.

HOT NICKEL SOLUTIONS.—As a general rule nickel cannot be deposited beyond a certain thickness upon any work. After it has attained its maximum thickness, it separates or peels up from the work of its own accord. This is owing to the tension of the particles of metal being deposited. When this tension exerts a force greater than the adhesion of the nickel to the work the coating of nickel will break and be torn off. A thicker and heavier deposit may, however, be obtained by heating the solution and keeping it hot by means of steam pipes or otherwise. It should be kept between 150° F. and 190° F. Nickel solutions which are used hot should be filtered from time to time and kept clean, as in a hot solution the mud at the bottom is more apt to become mixed with the solution, causing a rough deposit. The hot solution is not in general use and is recommended only where extra heavy deposits are required.

Doctoring with Steam.—I have always found live steam an infallible remedy where everything else failed for fixing up a "sick" nickel solution. Solutions very often become too alkaline from the careless use of the cyanide dip and caustic potash which is not thoroughly rinsed from the work and is very often left inside hollow pieces. This causes the work to come from the solution a dark blue shade and the plate does not adhere well. Then the solution may become too acid in the careless handling of iron or steel work to be nickel plated where pickles and acid dips are used. This causes the work to be hard, brittle and peel off readily. There are many other causes for these effects, but as the remedy is the same in each case it will not be necessary to give them. Where the usual antidotes fail it will be found that a vigorous boiling of the solution with a hose attached to a live steam pipe with a pipe at the other end of the hose to be thrust into the solution with a valve to control the steam. If boiled for one-half hour in this way, it will be found that all the alkali and acids have been recombined. Then the solution should be allowed to cool and will generally work as well as when new. If the solution is not too large, it may be removed and boiled in a clean barrel arranged for the purpose or in large crocks; but where the solution is too bulky for this the steam may be brought to the solution vat by means of a hose and the pipe at the end immersed well down near the bottom of the vat. Solutions should never be boiled with much mud in the bottom. It must be removed first.

Moving Solutions.—The sediment and mud at the bottom of the nickel solution is caused mostly by alloys and impurities in anodes and chemicals, also partly by dust and dirt settling in them. It should be removed from time to time, as it is bound to be stirred up by fishing for work which has fallen to the bottom of the tank. This sediment being mixed through the solution then settles upon the work being plated, causing a roughness which is very detrimental to good work. In removing this sediment the solution should be allowed to settle over night and then draw off with a rubber hose in the form of a syphon. Throw away the mud, rinse out the vat and pour the solution back through a cotton or cotton flannel strainer nailed on sticks and laid across the vat. Then add water to fill the vat to the proper height and nickel salts to maintain its specific gravity.

In handling a solution as indicated above, or in moving it when going to a new place of business, great care must be taken to use only new and clean barrels for holding the nickel solution. Nearly every month the supply dealers are appealed to for aid in fixing up a nickel solution which has been put into kerosene, alcohol or whiskey barrels, or even beer barrels—anything that does not leak. Such a solution when once contaminated, can never be made to give first-class results afterwards. The only remedy is to make a new one. If you have an empty tank, well lined, it may be washed and used to hold any solutions while filtering them and cleaning up the working tank. If not, get new barrels; line them with tank lining and keep them for this purpose only. It will save money in the long run.

Protecting Anode Rods.—The anode rods and hooks on the plating vats, especially of nickel solutions, but on cyanide solutions of different kinds as well, may be protected from the drippings of solution and water and thereby save a good deal of labor in the cleaning of the rods and hooks. The best device where the material is at hand is to take an old rubber hose, one or one and one-half inches in diameter, cut it into lengths of the inside measurement of the vat and then with a sharp knife slit it up one side, from end to end. Then spring it over the anode rod, hooks and all. You will find that by taking advantage of this simple device, cleaning the rods will be required only once a week instead of every day, or twice a day in some very busy shops. Thin, narrow boards may be fitted over the rods and given a slant into the vat, which will answer; or strips of oilcloth may be bound around the rods to protect them where the hose is not available.

To Get the Greatest Capacity.—In the busy nickel plating room, where large quantities of small and cheap work are handled a very good plan to follow is to reduce the current sufficiently when beginning to fill the vat, gradually increasing the current as the vat fills with work, until the vat is full and you are using all the current possible without burning corners or projecting parts. By the time the vat is full from twenty to thirty minutes will have elapsed; then you may start at the first end again, taking out and hanging in the work. This may be kept up all day if the amount of work demands it. Thus you are working your solution to its fullest capacity. In this way much time may be saved and the amount of work done in a single tank is greatly increased. Some platers do not like this plan, as it causes too much physical exertion. They prefer the old way of filling up the vats and then sitting down until it is time to put in another lot of work, that time being easily controlled by the switchboard, according to the ambition of the operator.

Nickel Anodes.—Theoretically it should be possible to feed a nickel solution entirely from the anodes. Practically this is impossible in the average shop, although it is universally recognized as the cheapest method of adding nickel to the solution and skillful platers succeed in doing it for several weeks, or even for several months, at a time. Exhaustive studies have been made of the character and composition of the metal and the shapes which are desirable. These show that rolled anodes will feed a solution sparingly and such a solution must have constant additions of nickel salts. Electrolytically deposited nickel anodes were tried with the idea of securing a perfectly pure anode, but it was found that they also fed the solution poorly, being just the reverse of copper. Cast nickel anodes of a fine and close texture of metal of great purity were also tried, and while better than those previously mentioned, still left much to be desired. A rather coarse, porous casting is very easily disintegrated in the solution, particularly if it contains certain impurities, such as cobalt, carbon, traces of iron, traces of copper, etc. It has been determined by patient investigation that this is due to two principal causes; first, the amount of surface open to contact with the solution is enormously increased in a coarse casting as compared with the close, even texture of rolled metal; second, the presence of carbon, for instance, sets up a local action, the carbon, nickel and sulphuric acid forming a battery which decomposes the anode by local action, leaving the resulting salts free to be seized upon by the current and carried into the solution. This local action and the increased surface, together, operating to feed the solution, will give it a greater constancy than could be obtained by using purer metal in the anodes. For this reason carbon is generally added (or rather left in) when casting the anodes.

It has also been determined that the current, in leaving the anodes and passing into the solution, does so far more readily from the points and edges of the anode than from the middle of a flat plate; also that in the corrugated anodes illustrated in this chapter there is a tendency for the corrugations to wear flat, showing that the metal is eaten away more rapidly from the tops of the curves than from the bottoms. That this is due to the uneven flow of the current and not to any peculiarity of the anode is shown by the fact that when a plater is coppering a wide object—a large cast iron panel, for instance—if he has trouble in getting metal on the center of his work, he removes the wide anodes from opposite the center of the work and hangs a number of narrow ones in place of them. When this is done more metal is thrown on the center of the panel, every time, showing conclusively that the current is fed to the solution faster from the edges than from the center of a wide anode. Followed to its conclusion this would seem to indicate that the best anode would be all edges. While this is, of course, an absurdity, it is nevertheless true that platers generally have been using anodes which have been too wide to secure the maximum corrosion with the least expenditure of current in a nickel bath, and there is a constant tendency toward the use of narrower shapes, in order to feed the solution as evenly as possible throughout its entire contents, rather than to have streams which are richer in metal flowing from certain points.

There is a secondary advantage in the distribution of current in that more hooks are required to suspend narrow anodes and thus the current will flow more easily from the anode rod into the solution. We suspect that this may also have something to do with the undeniable fact that narrow anodes will feed a solution faster and more evenly than wide ones. In copper, silver and other solutions which corrode them easily, the shape of the anode is comparatively unimportant, except in special cases. In solutions which must be fed with metals in a more expensive form (such as their salts), to make up any deficiency of the anodes, the sizes, number of connections and shapes of the anodes are well worth looking after; and this is particularly the case with nickel, on account of its extensive use.

Figs. 69 and 70 show two forms of anodes with cast hooks. While there is some liability of the hooks breaking in shipment and handling, they are preferred by many platers on account of the fact that when using them no copper will get into the nickel solution from the hooks and spoil the color of the solution. The connection is also better electrically than with anodes having eyes for the insertion of copper hooks. They are made in any desired shapes and sizes. Fig. 70 shows an anode which is corrugated with the

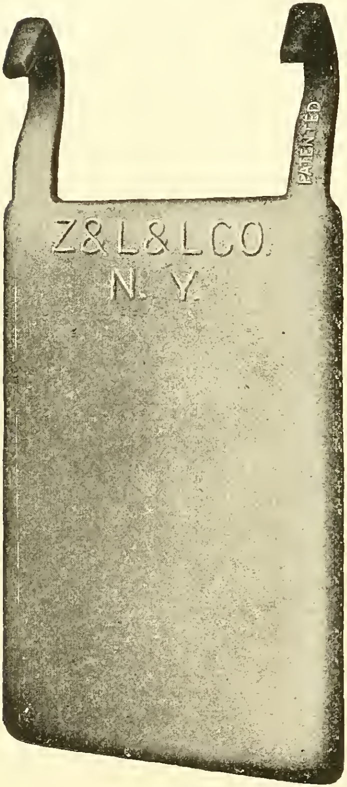

Fig. 69.

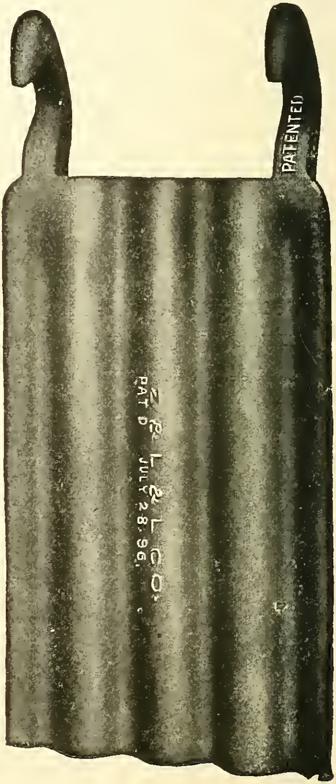

Fig. 70.

object of introducing a larger surface to the solution in a given length of anode rod. It is claimed that they also distribute the current more evenly than the flat anodes, as shown by those portions of the corrugations which are nearest, the work wearing away faster than the hollows on the same side of the sheet. Those who have given this anode extensive trial pronounce it a very satisfactory product, easily cleaned, wearing uniformly and feeding the solution freely. They also state that the amount of scrap nickel remaining in the hooks is more than compensated for by the better electrical connection and the fact that there are no copper anode hooks to clean.

Fig. 71 illustrates a new form of anode of elliptical section in which the results of the investigations of current distribution in the plating solution have been taken advantage of to produce a shape that will secure the maximum corrosion and even distribution throughout the solution. The new anode is elliptical in section and tapers in thickness from top to bottom rather more than is customary in the older forms of anodes. This is done to prevent cutting off at the top in solutions which are worked chiefly on small work which does not fill the vat, so that the bulk of the work is confined to the upper one-third of the solution. Anodes will cut off rapidly in such cases, particularly if the plater neglects to stir his solution, and anodes used on such work should be thickened at the top more than where the work is racked or strung to occupy the full available depth of the solution. Fig. 71 shows a round hook screwed into the anode and having its upper portion flattened. In use this flat portion is bent to exactly fit the curve of the rod, so as to get connection for fully one-half the circumference of the rod. In doing this the plater should see that the hooks have not been bent out of alignment with the anode or the flat portion of the wire will not lie down on the rod for its full width, but will stand on one edge and thus greatly reduce

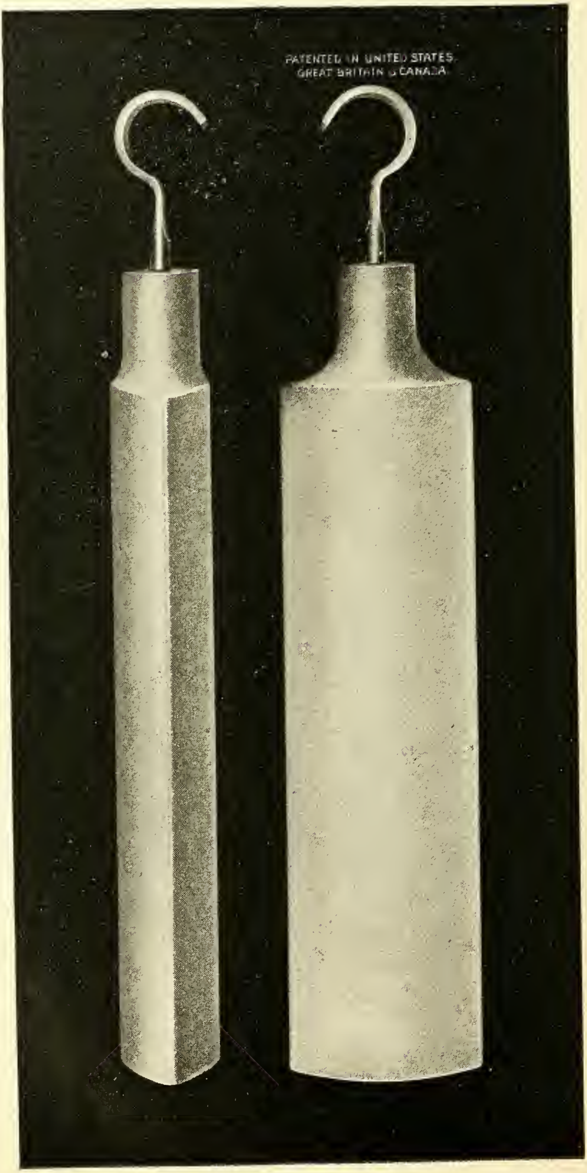
PATENTED IN UNITED STATES
GREAT BRITAIN & CANADA.

Fig. 71.

the conductivity of the hook by reducing the surface in contact.

While speaking of anodes, another point may be mentioned, which is the custom that many platers have of hanging a copper wire on the cathode rod to take part of the current when there is too much current for the amount of work that is being done. A nickel anode should be used, but sometimes the plater has no anode for such a purpose, as he is using them all on the other rod in an attempt to drive more metal into the solution, or the work may be of such a character that there is no room to hang a wide anode on the work rod; so he resorts to copper wires and allows a number of them to hang on the work rod here and there between the pieces of work. It is usually a large wire and dips into the solution about twelve inches. In time these become covered with deposited nickel until they are from three-fourths to an inch in diameter, when they are taken out and sold as scrap nickel at a considerable reduction in price. It is common to see the plater make a loss on from one hundred to four hundred pounds of nickel in this way, because he does not want to run the risk of getting copper in his solution, if he tries to run them as anodes. A few nickel wires of a size suitable for such uses would cost very little and then the plater who uses such means of cutting down his current would be able to save all this nickel by simply changing them over to the anode rod when they become too large for his purpose and running off the deposited nickel with no danger of fouling his solution.

Nickel anodes very seldom require to be removed from the solution except those that have become somewhat worn from long service. New anodes in a properly balanced solution may not have to be removed from the solution for six months, unless it be to dip and clean the anodes and the connecting hooks. There are a few exceptions to this general rule.

In case the solution becomes too dense in metal, from adding too much sulphate of nickel, the anodes may be covered with a deposit of nickel crystals. Then the anodes become insulated and little or no deposit will be obtainable. When this happens remove the anodes and dip them in boiling water until the crystals are dissolved. When the anodes are clean the dissolved salts may be returned to the solution. In order to prevent the recurrence of the trouble the density of the solution may be somewhat reduced by the addition of water.

When nickel anodes have been in constant use for a long time, it will be found that upon their surfaces they have thick layers of carbon. This is of no value and should be removed with an old file or scratch brush and the anode thoroughly washed, when it will be found to have become much thinner. The cause of this is that in the process of melting the nickel for anodes it is mixed with coal or coke and when being cast a certain amount of this in the form of carbon remains in the metal, as previously explained in speaking of the conductivity of anodes. Nickel anodes that are being used constantly should be removed from the bath, brushed and washed two or three times a week.

For nickel plating work that has hollows or indentations it will be found advisable to use a solution rich in metal, as nickel is generally hard to deposit upon the inside of an article, and of course if made rich in metal it will be a better conductor of electricity, but it should never be made rich enough to cause a dark deposit, which is sometimes the case. For ordinary work the solution standing from 6° B. to 6½° B. is all that is required and any richer solution is only a waste of nickel salts. If the plater has an odd job of this kind and does not want to change his solution, he may hang his work with several hooks or wires so as to bring the hollow under the work rod; then take a narrow anode (very small) and wire it with a long wire to the anode rod with a rubber tube two inches long, slit up one side, slipped over the cathode rod; then he may drop this small anode into the hollow object (taking care not to get it too close) and hold it in position by bending the wire so as to hang the anode from the work rod, as the rubber will insulate the anode from the work rod. A little ingenuity along these lines in handling work will frequently save hours of trouble and vexation.

CHAPTER XI.

COPPER SOLUTIONS.

The copper solution is one of the most common and also one of the most useful and easiest to handle. Every plating establishment, great or small, has its copper solution for one purpose or another. Some for copper plating iron and steel preparatory to nickeling; others for coppering work preparatory to oxidizing or lacquering as the final finish. So, as it has many and varied uses, is inexpensive and easily handled, it is found either in a large or small quantity in every plating shop in the country.

Copper solutions, being composed of but one metal, are comparatively easy to make and to work. If the solution contains too much free cyanide, the work will plate brittle, blister easily and the deposit will be thin; if there is a large excess of free cyanide the solution will work vigorously, giving off considerable gas at the cathode, but the cathode receives no deposit. The remedy for this is the addition of carbonate of copper, which will reduce the proportion of free cyanide, or if the solution has a sufficient quantity of copper, remove some of the solution and fill up the vat with water to reduce its density.

If there is too much copper in the solution, the anodes will become coated and finally refuse to deposit. In that case the anodes should be removed and cleaned and more cyanide added to the solution. When the solution is in a proper condition the anodes, when in use, will be covered with a thin oxide which, however, is soon dissolved and the anodes become bright when the solution is at rest.

Copper solutions for ordinary work plated upon wires should stand 8° B. to 12° B. on the hydrometer, while those being used for basket work should be of a greater density, usually from 10° B. to 15° B.

Some platers prefer to have their copper solutions stand from 16° to 20° B.; in such solutions the current is usually cut down very low and the work plated slowly to prevent burning or blistering. A copper solution very rich in metal and cyanide is more apt to blister in plating if allowed to remain too long in the solution, especially is this so if there is a large excess of cyanide.

Carbonate of copper and cyanide of potash in proper quantities must be added from time to time to feed the solution, according to the amount of work being plated. In adding large quantities of copper and cyanide to solutions of copper, after stirring, a thick brown scum will be formed upon the surface of the solution which should be removed before proceding to plate.

Water	1	gal.
C. P. cyanide of potash	½	lb.
Carbonate of copper	6	oz.
Carbonate of soda	3	oz.

Copper solution for basket work:

Water	1	gal.
C. P. cyanide of potash	1	lb.
Carbonate of copper	10	oz.
Hyposulphite of soda	1	oz.

Small quantities of hyposulphite of soda dissolved in water and added to any copper solution will immediately remove that brown scum which so often forms upon the object being plated.

Copper plated goods, upon being removed from the bath, should be rinsed in water, then dipped for a minute or two into a solution composed of one part sulphuric acid to fifty parts of water, before being dried in hot water and sawdust. This will kill the cyanide in the pores of the plate and prevent to a considerable extent spotted and tarnished copper plated goods, as this defect is most frequently caused by a failure to remove all the cyanide from the article before drying.

DUPLEX OR ACID COPPER.—The acid copper solution has been in use for many years in the electrotyping trade, but until recently it was not considered of much importance to the electroplater. As the great amount of work required to be plated from year to year steadily increased and methods were discovered for doing cheaper and better work, the great value of the acid copper solution was finally recognized by the electroplater, particularly as an aid to good nickel plating, and also as a means of reducing the time and cost of polishing iron and steel goods, to say nothing of its value as a coppering solution for plating articles which are to be oxidized or finished in the copper plate itself. In a great many shops the acid copper has almost entirely replaced the cyanide of copper solution. In the first place it is very much cheaper than cyanide solution, costing not more than one-fifth as much. It will deposit ten times the amount of copper in a given time with less current than the cyanide of copper. The plate is not so liable to peel, nor is it so easily cut through when in the process of buffing, as it is thicker. It is a time saver, as a heavy deposit may be obtained in a short time, while very little current is required.

The great and only drawback to the use of this solution is the fact that it will not plate directly upon iron, steel or zinc, as these metals, upon coming in contact with the acid in the solution, are immediately attacked and decomposed. To overcome this difficulty, it is necessary to first plate all iron, steel or zinc goods either in the cyanide of copper or in the nickel solution, just giving them sufficient plate to protect the metal from the corrosive action of the acid in the acid copper solution. Then they may be rinsed off in cold water and hung into the acid copper.

Blow holes or flaws in castings should be filled with solder to prevent the acid solution from entering such places and attacking the metal. Pieces with holes in them or hollow castings should be filled with water and corked up when possible, or the cavities filled with resin or wax to prevent the entrance of the acid copper solution. It is seldom necessary to run the work for more than fifteen to twenty minutes in this solution, a very heavy deposit with a weak current being obtained in that length of time. The acid copper solution has been a great boon to large manufacturers of bicycles, stoves and other articles requiring a good, substantial deposit of nickel. Iron and steel work that, before the use of acid copper in the plating room, had to be run over four or five wheels in the polishing room, to get the desired finish, now may be finished on two to three wheels. Where the work required a finishing wheel of flour emery after the 120 or 150 emery wheel, now it may be finished upon a 120 or 150 grease wheel. The reason for this is that the copper can be deposited so heavily upon the polished iron or steel work that in the process of buffing it may in a measure be polished down into the lines or scratches left by the grease wheel. Then those lines or scratches that may still remain are so highly polished that, after receiving a heavy deposit of nickel upon the copper and then being buffed again, the scratches cannot be detected. This process would be utterly impossible when using the cyanide of copper solution, because the deposit could not be put on sufficiently heavy to stand buffing down enough to hide any defects in polishing. Furthermore, the heavy copper deposit makes a better surface upon which to deposit the nickel, at the same time protecting the article from rusting and thereby increasing its usefulness.

To Make the Solution.—The usual formula for acid copper is as follows: First fill the vat which is to contain the solution one-half full of water, as free from lime as possible. Then dissolve blue vitriol in hot water, by using the steam pipe in a jar as described for nickel, or by boiling. The plater must not use any iron, tin or zinc vessel in connection with this solution, as it will readily destroy anything of that nature. Add the hot sulphate of copper solution to the water in the plating tank until the solution in the vat stands at 15° B. Then if the solution is to the desired height in the vat, add sulphuric acid slowly and with stirring until it stands 20° B. The solution, when thoroughly cool, is ready for use. Use pure copper anodes in this solution, either cast or rolled.

The same solution, but of less density, is as follows: Make the solution of sulphate of copper so that it stands at 12° B. Then add sulphuric acid until it stands at 15° B. The use of sulphuric acid in these solutions is to give them greater conductivity; at the same time the excess of free sulphuric acid tends to produce a fine-grained deposit which would not be obtainable without the free acid.

The size of the tub used to contain the acid copper solution has considerable bearing on just what the proportions of that solution should be. For instance, a solution standing from 15° B. to 18° B. will give satisfactory results in large vats where the volume of solution is considerable and the distance from anode to cathode is from eight to ten inches. But if used in small quantities in a smaller and narrow vat, where the work is close to the anode, a solution of much less density will give better results. The formulae first given are suitable for electrotyping.

The formula in most general use for electroplating consists of a solution made to stand about 13° B. by adding sulphate of copper and then bringing it up to 15° B. by the addition of sulphuric acid. These proportions may be varied a little, according to the size of the vat, amount of solution and class of work to be handled. It is better to have the acid copper too low in metal, rather than too dense.

Care must be taken in using this solution not to use an excess of current. It being a very dense solution and an excellent conductor of electricity, much less current is necessary to accomplish the same amount of work than with any other solution.

There should never be an evolution of hydrogen from the work when being plated in the acid copper bath. If this occurs, you will know that your work is burning, in which case it will take on a brown color and crumble from the work, or be easily brushed off. Gas may arise from the solution if iron, steel or zinc is being plated, if they have not been properly coated before going into the acid copper, either in the cyanide copper or in the nickel solution. In this case the solution readily attacks the iron, steel or zinc and such work must be immediately removed from the solution. Too much stress can hardly be laid upon this point, that all articles of iron, steel or zinc must be thoroughly coated in either cyanide copper or nickel solution before going into the acid copper bath. In castings that are porous, or have sand holes, the holes should be filled with soft solder before plating.

This solution, properly handled on certain classes of work, will be found the best and most economical. Due precaution should be taken in selecting a vat or tank for the acid copper bath. If any great amount of solution is to be used, say 200 gallons or over, the tank should be made of well seasoned lumber, not less than two inches thick, well bolted at the ends and along the bottom and then properly lined with cheese cloth and asphaltum. The reason for this extra precaution is that this solution, being very heavy, is liable to bulge or spring the sides of a large tub if not properly bolted and braced.

SIMPLE IMMERSION COPPERING.—A very cheap copper plate may be deposited upon iron or steel objects by first cleansing them by dipping into or brushing with a strong solution of hot sal soda (caustic soda). When clean give a quick dip, moving about constantly, into a solution of sulphate of copper and sulphuric acid about as follows:

Sulphate of copper	1½	oz.
Sulphuric acid	1	oz.
Water	5	qts.

The article, if left in the solution after the film or plate of copper is formed, is liable to redissolve, or peel off, so it should be removed quickly, rinsed in plenty of cold and then in hot water and dried.

This process is much in use upon small iron novelties and cheap hardware, such as furniture casters, transom lifts, window locks and other such goods of the cheaper grade. Upon articles too large or of a shape that prevents dipping, the copper may be deposited by first cleaning the article with a brush dipped into the hot soda solution, then brushing the object to be coppered, then use another brush and apply the copper solution in the same manner, brushing evenly and only once in a place, as if brushed repeatedly the deposit will not adhere well.

Another way of coating small iron or steel objects with the copper film without the use of the electric current, or even the trouble of preparing the above formula, is to wire them or place in a basket and cleanse in the usual manner by potashing, then immerse for a moment in an old acid bright dip; one that has been long in use is preferable, as it is saturated with copper salts. The moment the iron or steel objects come in contact with this solution they receive a bright deposit of copper which should be quickly removed, rinsed and dried as before.

CHAPTER XII.

BRASS PLATING.

Brass plating is perhaps the most difficult branch of the line of plating. This is due mostly to the fact that two metals are used in combination in the solution. It is often very hard to get them together in the solution in just the right quantities to produce the exact shade of deposit required. Furthermore many platers insist upon putting this, that or the other thing in their brass solutions without being able to give any suitable reason why they do it.

It has been noticed by the writer that cyanide seems to be the cure-all among platers, especially when they do not know what the trouble is. They resort to cyanide if the work peels, is too dark, too light, muddy, or gray, is spotted or streaked, or does not plate fast enough. The inexperienced operator, not knowing the cause of any particular trouble, usually attempts to remedy it by the free use of cyanide, which at best is only guess work, and nine times out of ten, only makes matters worse. It is more difficult to lay down exact and permanent formulae for brass plating than any other solution, on account of the solution being composed of two metals of different electrical conductivity. A solution that would give satisfactory results upon small steel or iron goods would very likely be useless upon large castings of iron or zinc, while a solution capable of giving the required results upon large castings would be of no value upon basket work, such as small novelty goods, screws, nails, rivets and other small work usually handled in baskets. With brass solutions more than any other the class of work to be handled, the anodes, the composition of the solution, the amount of current to be used, the distance of the cathode from the anode, must all be taken into consideration and are important factors in getting the best results upon the different classes of work. The best solutions are those which will give the desired results and be the easiest to keep in condition to give uniform results. It has been proven of late years that the solutions best adapted to comply with these conditions are those which are of the most simple construction. Having only the absolutely necessary ingredients in them, they consequently are much easier to handle and keep in order than those having many more elements, some of which are useless. Platers use much that is of no value to them in preparing these solutions, because the book says so, not knowing the reason why they should be in the formula.

A great many solutions recommended for brass plating are obsolete and should not be given book space. Many of them were used twenty-five or thirty years ago when brass plating was not very successful in a commercial way, and these old recipes have been passed along from one writer to another without anybody giving them a practical demonstration to see whether they were of real value or not. Knowing this to be a fact, not only with brass solutions, but with others also, it will be the aim in this book not to print anything that we do not know will do what is claimed for it. Those things which the writer does not know from his own knowledge and experience will be secured from practical platers in that particular line, or failing in this, experiment will be made and all formulae given practical working tests where any doubt exists as to their value and efficiency.

The causes of trouble in brass plating are numerous. In the first place when the solution has been prepared so that the work is coming from it with the desired color, it is wise to use the solution every day. Even if there is no work at hand that requires brass plating, some pieces of metal should be hung in and run for an hour or two each day, because when the solution is left standing idle for a day or two, or a few days at most, the metals suspended in the solution become separated owing to the difference in their specific gravity. Then the next time it is wanted for use, perhaps in a hurry, it will usually be found to plate spotted or streaked, or perhaps it will plate all zinc or nearly all copper; sometimes it requires considerable labor and skill to remedy the evil. It may be set right in a few minutes, or it may take hours; but if the solution is run or electrolized for an hour or two each day and then given a thorough stirring up at night, this particular form of trouble may be averted.

It is a good practice to stir up the brass solution thoroughly from the bottom at the close of each day's work, whether in actual use or not; this helps to keep the metals in solution well mixed or amalgamated and tends to produce uniform results.

Free cyanide in any solution is that portion over and above the amount which is required to dissolve and keep the metals suspended in the solution. Too much free cyanide in brass solutions is very troublesome where a good, heavy deposit is required which must stand buffing. An excess of cyanide greatly increases the conductivity and causes the work to be plated so rapidly that the deposit is usually hard, brittle and blisters or peels up of its own accord long before the required thickness is deposited. It also tends to make the deposit of a pale, insipid color. The remedy for this, in case it is not desirable to add any more copper or zinc carbonate to the solution, is to dip out a quantity of the solution, replacing it with water and mix it up well. This will usually give satisfactory results. But if more carbonate may be added without injuring the color of the deposit, this will reduce the excessive proportion of free cyanide of potash, but will also increase the specific gravity of the solution. When there is too much free cyanide in the brass solution it may be easily detected by a number of indications. First, the anodes will remain bright, or partly so, when plating, which they should not do; then the action of the solution about the work will be greatly increased, also the amount of gas given off by the work being plated is beyond the normal and usually forms a thick scum over the solution. If the free cyanide is greatly in excess, the action of the solution will be greatly increased, yet the work to be plated will receive no deposit whatever.

When there is a lack of free cyanide in the solution, it will be noticed that the solution works slowly; the anodes become coated with an oxide or scum which finally entirely covers over or insulates the anode, making it a nonconductor; then all action or deposit ceases. The remedy for this is the addition to the solution of cyanide of potash in small quantities, with stirring, until the work will plate steadily and the action of the solution is uniform. There are times when it would not be desirable to add cyanide, as, for example, when the color is just what is required, there may be danger of altering it by the addition of cyanide. In this case the anodes must be removed from the solution, one at a time and cleaned by dipping in hot potash and brushing with a stiff brush to remove the scum. This will immediately increase the action of the solution. After it has been run for a time, the surplus metal will be reduced and the cleaning of the anodes will not be necessary. In a properly balanced solution the anodes should slowly turn bright in the solution when not in use.

Cast brass anodes are the best for plating, as the metal is usually softer and more easily deposited than rolled brass. The cast anodes may easily be had of the same color as the deposit required, which is quite an advantage. The hooks for brass anodes should be made of heavy copper wire the same sizes of the holes in the ears of the anodes, so that they may be driven in snugly and riveted, thus insuring a perfect electrical connection which will not be interfered with when the anodes corrode about the hooks at the surface of the solution. If sheet brass anodes are used they should be annealed to soften them. The anodes should be of good size, reaching nearly to the bottom of the vat, and there must always be anode surface equal to or in excess of the surface of the work which is being plated.

The distance of the cathode from the anode is an important factor in brass plating. The most uniform results are obtained upon ordinary work at a distance of six to eight inches. A shorter distance, say, from three to four inches, may make the deposit too light in color and brittle, while the distance of ten to twelve inches might make the deposit too dark, or even red, at the same time plating slowly on account of the increased distance and consequently increased resistance of the solution, which cuts down the effective amount of current.

The manipulation of the electric current is one of the most important things to be considered in connection with brass plating, as all the shades from a rich bronze to a light brass may be obtained from the brass solution by the regulation of the current. Brass solutions usually require considerable current to get the lighter shades, as more zinc than copper is deposited from the solution with a strong current. As the current is reduced, more copper is deposited, until the shade of the deposit will gradually run into a bronze color. All these things, of course, depend somewhat upon the class of work being done, the condition of the solution and, most of all, upon the skill of the operator. No positive rules can be laid down for the management of brass solutions. The reader will glean what he can from these general statements applying to brass solutions and apply them to his particular class of work.

The ingredients for making brass solutions may be purchased from any reliable dealer in plating supplies, but it is well to know how to prepare the chemicals in most common use, as they may be wanted in a hurry, and then you know just what you have if you make it yourself.

To Make Carbonate of Copper.—Take sulphate of copper (blue vitriol) to the required amount, weigh it and dissolve it in a wooden pail or a crock, with hot water and stirring. Then pour the liquid into a large and deep crock, not allowing any undissolved vitriol to get into the larger crock. Dissolve in hot water in another vessel about two pounds of carbonate of soda (sal soda, or washing soda) for every pound of vitriol previously dissolved. Add the soda solution to the vitriol solution in the high crock. Do this slowly, with stirring, so as to allow the carbonic acid gas to escape. If too much soda solution is added to the vitriol at once the large quantities of gas suddenly liberated will cause the liquid to boil over, thus wasting the copper. When the chemical action ceases, after stirring up well, do not add any more soda solution, but fill up with hot water the crock containing the copper, which is now carbonate, and allow it to settle. Then pour or syphon off the clear liquid, which is sulphate of soda and is of no value. Fill up the crock containing the carbonate with hot water, stir, allow to settle, pour off and repeat the washing until no taste of soda is apparent in the water by wetting the end of the finger and placing it on the tongue. The last washings should be of clean, cold water. When the carbonate is washed clean it is ready for use, but that portion which is not required for immediate use should be kept in a wide mouthed bottle with water over it to prevent it from drying out, as if it is allowed to get dry it is hard to dissolve.

Carbonate of Zinc.—This is made in exactly the same way, from sulphate of zinc. Usually not so much carbonate of zinc is made at a time, as much less zinc is used in brass or bronze solutions than of copper.

Preparation of the Work.—It will be found advantageous to give iron and steel work a dip in a solution composed of one quart of muriatic acid to three gallons of water, after the work has been scoured and cleaned in the regulation way with a brush and powdered pumice stone, using a little cyanide of potash solution on the brush, which makes the removal of grease much easier. Then, instead of using the cyanide dip as the last dip before hanging into the plating bath, rinse the work, dip in the acid solution above given, then rinse again and hang in the plating bath. This will leave the metal in an adhesive condition, insuring a better and finer deposit than will be possible when using the cyanide dip as the finishing dip.

BRASS SOLUTION.—Contrary to the usual method of writers upon plating, I propose to give first a simple method of preparing a brass solution in a practical way which I have always found to give immediate and satisfactory results without following any given formula. The plan is simply this: Make up your copper solution in the vat which is to contain the brass bath, not using too much carbonate, but enough to give a nice, clear and uniform deposit of copper. Proceed by first filling the vat half full of water; then add C. P. cyanide one-half pound to each gallon of solution which the vat will contain when it is filled to within six or eight inches of the top. When this is done, add the carbonate of copper, which should be previously mixed up in a jar with water in the form of a paste; add this to the cyanide solution with stirring. See that the copper carbonate is all dissolved in the clear solution, which is readily accomplished by stirring. When the cyanide has taken up all the copper it can, the clear solution will begin to take on a greenish look. Cease adding the copper at once and stir up vigorously: then add enough cyanide to clear up the solution and leave a little in excess which is called free cyanide. Next dissolve ten pounds of carbonate of soda for each one hundred gallons of copper solution and add to the solution in the vat. Stir up well and let it settle for a few hours.

This solution should be transparent and almost colorless, with no sediment at the bottom; this is the regulation copper solution. Next connect up the vat with the dynamo, hang in your brass anodes and run the solution for a short time with a vigorous current, hanging on the work rod anything that is large enough to pass current freely.

Next make a solution in a jar, from carbonate of zinc and C. P. cyanide, adding all the zinc the cyanide will take up, but no more. Usually one-half the amount of zinc chloride is used as of copper chloride. When this zinc solution is prepared, hang in the copper solution the class of work which is to be brassed, or some similar work, for the purpose of working the bath. Now proceed to add the clear zinc solution to the copper solution, stirring up well from the bottom, while the solution is being worked with an ordinary current of about the proper force to run the bath when plating actual work. The deposit on the work should be watched closely. It will soon begin to change from copper to bronze, then into the lighter shades of bronze. The addition of zinc solution should now cease for the time being. Add one-half gallon of ammonia to each one hundred gallons of solution and stir up well. The ammonia helps to amalgamate the two metals and brings out the bright color so much desired. After adding the ammonia the solution should be run for some time and the current manipulated to get the desired shade. Do not add more zinc until you find it necessary. Very often a brass solution plating a light bronze color will gradually run into the shade desired by adding ammonia, working for a time and manipulating the current, whereas, if a little too much zinc is added, the solution very often changes suddenly and plates almost pure zinc, causing considerable trouble to get it back again. Too much care cannot be used in adding the zinc solution after the color of the deposit begins to change. Very often new brass baths as well as old ones plate uneven and streaked instead of having a uniform color. When the usual remedies have been tried and failed a vigorous boiling of the solution with a live steam pipe, afterwards allowing the solution to cool and settle over night, will usually be found to remedy the difficulty. If the brass bath be used while hot, a pure copper deposit will usually be obtained, running into the lighter shades of bronze and finally into brass as the solution becomes cold. This boiling process will evaporate considerable of the ammonia in the solution, so that it may be desirable to add more when the solution cools off, in order to bring the desired shade. The addition of ammonia to the brass bath has no detrimental effect.

BRASS SOLUTION.

C. P. cyanide of potash	1 lb.
Carbonate of copper	6 oz.
Carbonate of zinc	3 oz.
Carbonate of soda	2 oz.
Ammonia	3 oz.
Water	1 gal.

Macerate the copper and zinc carbonates in one-half the water, pulverizing all lumps; then add the cyanide, which should form a clear straw-colored liquid. If the carbonates are not all taken up in the clear solution and settle to the bottom, add cyanide slowly, with stirring, until the solution is clear. Dissolve the carbonate of soda in one-half gallon of hot water and add it to the first solution. Stir up well and boil it. When cool, add the ammonia, stir up, and it will be ready for use.

Ammonia should be added to this solution from time to time, when in constant use, or when being used only occasionally, as it evaporates quickly.

The next is the brass solution containing arsenious acid. This was one of the first solutions in practical use, and is used to-day by the old school of platers who insist upon sticking to the old way of doing things whether they possess any real merit or not The only objection to the use of arsenic in any form for the brass bath is that it makes that solution very erratic and hard to control, while ammonia seems to give all the beneficial results obtained by arsenic (which is simply to obtain a bright deposit) while it produces none of the detrimental features of the arsenic. Feeding arsenic to the brass bath is a good deal like feeding this and certain other drugs to the human system. Once started it must be kept up and the quantity gradually increased as the system or the solution becomes accustomed to it. An overdose of arsenic in the brass bath causes a whitish, pale deposit which is usually hard to rectify.

Water	6	qts.
C. P. cyanide of potash	18	oz.
Carbonate of copper	4	oz.
Carbonate of zinc	3	oz.
Carbonate of soda	2	oz.
Arsenious acid	½	dwt.

Prepare the solution like the previous one, adding the arsenious acid last.

Water	3	gal.
C. P. cyanide of potash	2½	lbs.
Carbonate of copper	1	lb.
Carbonate of zinc	½	lb.
Caustic potash	1	lb.

Add the caustic potash last. The addition of caustic potash in the place of carbonate of soda seems to increase the conductivity of the solution while it answers the same purpose as the carbonate of soda in bringing out a bright deposit.

Brass solutions for ordinary work, such as iron or steel stampings or castings, or any work to be wired upon copper wires, should never stand over 15° B. While a bath at 10° B. to 12° B. usually gives the best results, a solution of greater density usually plates brittle and peels up readily.

Solutions intended for small work in baskets, such as trimmings, screws and other small work, should stand from 12°

B. to 20° B. For this class of work the solution is required to be of greater density, being rich in both metal and cyanide, as the circulation of the solution about the work in the baskets is not so free; also a greater volume of current is required when handling work in baskets.

Better results may be obtained in brass plating by first copper plating the articles to be brassed. They should also be buffed bright before going into the brass bath, if it is work requiring a polished brass finish. By so doing, it makes a more durable job with little or no expense, as the coppered article will not require such a heavy deposit of brass as it would without the preparatory coat of copper and will finish up better and much quicker.

Brass solutions that are in constant use need frequent addition of the proper salts and also cyanide of potash from time to time. Those being used continually for basket work require the addition of the different salts oftener than the ordinary solutions used upon work that is plated upon copper slinging wires.

Brass Anodes.—It is not necessary to remove the anodes from the brass or bronze solution, except for the purpose of cleaning. They are allowed to remain in the solution continually without any detrimental effect either to the anodes or the solution. It would be considerable inconvenience to remove them, as they would readily become covered with a film of oxide if left exposed to the action of the air, while if left in the solution, they remain bright and clean if the solution be in a normal condition.

In making up plating solutions of any kind, especially those where all the chemicals are purchased and not prepared by the operator himself, due allowance must always be made for impurities and loss of strength of the chemicals from being exposed to the air or from age. For instance, carbonate of copper may contain sulphuric acid by not using sufficient sal soda to neutralize all the acid contained in the sulphate of copper when preparing the carbonate. Again the carbonate may contain considerable sal soda from the lack of thorough washing in the preparation of the carbonate. The same may happen with zinc. In these days of keen competition improved methods of manufacture and sharp business methods unless one is able to distinguish for himself the difference between the pure and the impure chemicals he will find very often the given quantities laid down in a formula may fail utterly to give the desired result, whereupon the blame is usually at once laid upon the shoulders of the writer of the formula when, as a matter of fact, it is the fault of the chemicals.

Especially is this true in the manufacture of cyanide of potassium. The price has become so low from competition or otherwise that little true cyanide of potassium is obtainable, the bulk of the commercial article being cyanide of soda, which lacks certain well known characteristics of the true cyanide of potassium, hence more must be used and it must be added oftener to obtain the desired results. All these things must not be lost sight of in preparing solutions.

CHAPTER XIII.

BRONZE SOLUTIONS.

Considerable that has been said in regard to brass solutions applies also to bronze solutions in a modified form. Bronze being a composition of copper and tin, it would naturally follow that a bronze solution should be composed of the same metals. They may be and are, but do not give the best results. Brass being a composition of copper and zinc, so brass solutions are composed of copper and zinc salts, and also the bronze, or, more strictly speaking, the low brass solution which is in common use to-day and passes for bronze, as it gets the results. Bronze solutions are not nearly so difficult to handle as are brass solutions, for the reason that copper, being the predominating metal, is more easily controlled than where the two metals are used in more equal quantities. Still there being two metals present in the solution, it is somewhat difficult in making up the solution to get the desired color; but once obtained it is far easier to maintain a uniform color than with brass.

In handling solutions of mixed metals, great care and skill is necessary in plating large quantities of work of the same kind, or belonging to the same job, where the same color is required throughout.

Some writers give several formulae for bronze plating, composed of the different copper and tin salts as the principal ingredients. After giving the formulae and dwelling for some length upon their properties and construction they wind up with the statement that the formulae upon being tried were found to be worthless, or at best gave very unsatisfactory results. I fail to see the wisdom of printing a thing, only to condemn it.

Bronze solutions should be prepared as described in the first solution for brass plating, by running the work and adding the solution of carbonate of zinc and cyanide in very small portions and very slowly until the desired results are obtained. Cast bronze anodes should be used; then, by regulating the current by means of the rheostat, or switchboard (with which each vat should be supplied), the color may be regulated to any shade desired, from a very dark bronze, or copper color, to the lightest shades of bronze, sometimes (with intense current) running into brass.

BRONZE SOLUTION.

Water	1 gal.
C. P. Cyanide of Potash	8 oz.
Carbonate of Copper	4 oz.
Carbonate of Zinc	1 oz.
Carbonate of Soda	2 oz.

To be made up in the same manner as brass solution.

Water	1½ gal.
C. P. Cyanide of Potash	10 oz.
Carbonate of Copper	6 oz.
Carbonate of Zinc	2 oz.
Liquid Ammonia (FFFF)	½ pt.

Ammonia may be added to this solution as the occasion requires, but not in such large quantities as to the brass solution.

Bronze and brass plated goods, especially in builders' hardware, where heavy deposits are required, may be removed from the solution and scratch brushed upon brass wire scratch brushes, then given another plate. Or the goods may be scratch brushed before buffing, which will remove the scum from the plated work, giving a smoother and firmer surface to receive the polish. When this is done so much of the plate will not be removed by the buffing process as when the goods are not first scratch brushed.

Bronze solution used to plate large quantities of work requiring a heavy deposit, also solutions for basket use, may be somewhat richer in metal and cyanide, as follows:

Water	1	gal.
C. P. Cyanide	1½	lb.
Carbonate of Copper	¾	lb.
Carbonate of Zinc	3	oz.

Bronze solution using tin instead of zinc:

Water	1	gal.
C. P. Cyanide	1	lb.
Carbonate of Copper	10	oz.
Carbonate of Tin	2	oz.
Liquid Ammonia	4	oz.

CHAPTER XIV.

ROLLING BARRELS FOR POLISHING.

Small goods of uniform shape and size are usually rolled up in a metal or wooden barrel or keg, running at an angle of about forty-five degrees and from one hundred to one hundred and fifty revolutions per minute. A handful of soap powder should be thrown on the work being rolled, with enough water to make a good lather, which will both clean and polish the small articles. When sufficiently polished they are dipped out into the plating baskets, rinsed in water, then potashed, rinsed again and are ready for the copper or brass bath. The plated goods may be further polished by rolling up in a horizontal barrel filled with sawdust or leather scraps. This will give a polish equal to buffing, but care must be taken not to roll the goods too long and to keep the barrel full, otherwise the plate will be easily worn from the edges. From ten to fifteen minutes is usually long enough to polish after plating, according to the thickness of deposit and the brightness of polish required.

Plating by the Rolling Basket Process.—This is a process somewhat new in the electroplating business. It is not adapted to all classes of work, but upon work suitable for the process it gives very satisfactory results as to the amount of work that can be handled in a given time, the cheapness of plating goods in this way and the appearance of the goods when finished. The work usually plated in this way, of course, is generally the cheaper grades of goods and something not requiring a heavy plate, but one presenting a good appearance for the time being. The metals most suitable for this process are white metal, brittania of different grades, hard or soft, zinc, steel and iron. All sorts of novelties are cast by automatic machines from a composition composed mostly of lead, such as collar buttons, cuff buttons, small animals, toys, etc. Also screws, rivets and washers made from iron and steel. Harness buckles, suspender buckles and many other small metal articles may be handled in very large quantities in this way, doing away entirely with all wiring, hand cleaning and other necessary operations that require valuable time with the ordinary way of plating. With this process properly working a man and one helper could plate more work in one day than they could possibly plate in a week by the ordinary methods.

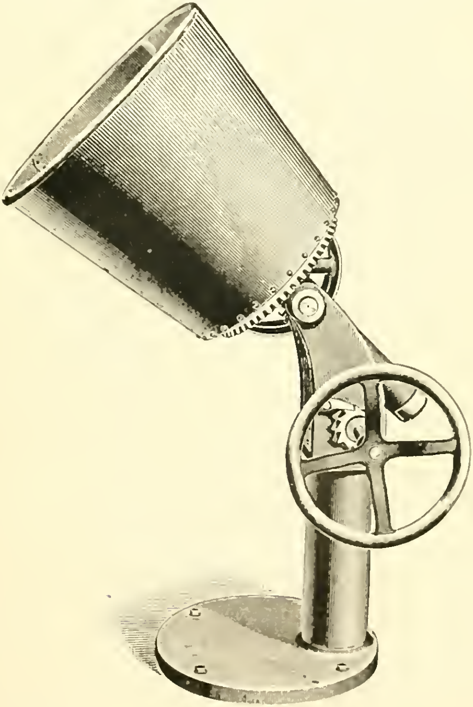

Fig. 72.

The work is handled as follows: If dirty or greasy it should be rolled up in the rolling barrel with soap powder. (See rolling barrel.) After cleaning it should be thoroughly rinsed, when it is ready for the revolving plating basket or tub. (See cut.) New work, such as small castings, may need no preparatory cleaning, but may have to be rolled some time, if rough, in sawdust or leather scraps to remove burrs and roughness. This work is usually handled in wooden pails. Tin or galvanized iron will not do, as the strong cyanide solutions readily attacks the zinc or tin and causes the work to be discolored. One ordinary pailful usually constitutes a batch, though more may be put in, depending upon the size of the basket. The baskets, of which we give illustrations,

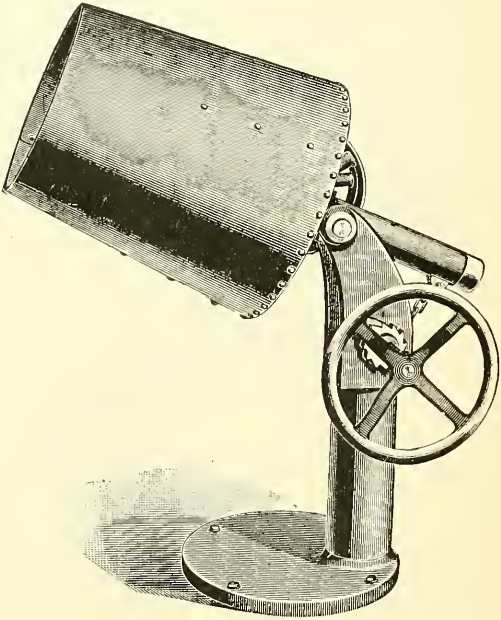

Fig. 73

are in everyday use in Chicago by a man who has made a specialty of this kind of plating, has had several years of experience with it and has been eminently successful. He prefers them of rather small size, as they are economical in regard to space, easily handled and require less power to operate the basket. In the latest approved method as illustrated in Fig. 74 it will be seen that there are six baskets revolving in one tank. The advantages of this method over the separate or independent tubs are many.

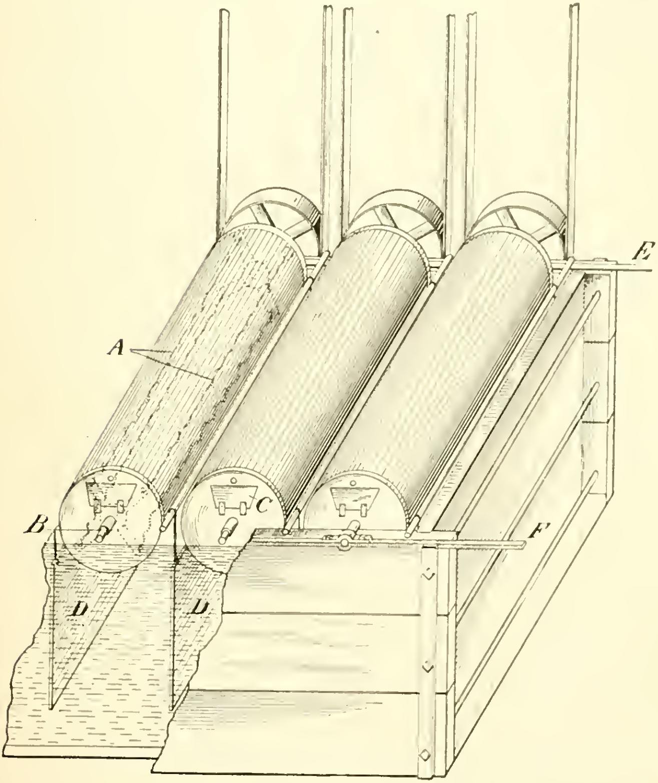

Fig. 74. **A, wires in basket; B, trunnion; C, door; D, Anodes; E, tank rod for current entering solution; F, return rod to dynamo.**

First, you only have one solution to keep up. Then the one large tank will not require as much space as several small ones will. One basket or all six may be operated at once, just as desired. One basket may be loaded up and started plating; then the others, one after another. By the time the last one is in the first is nearly ready to come out.

The solutions in most common use in the basket process are copper and nickel. The goods to be nickeled are coppered first. When they have been sufficiently plated and burnished by the continual revolving, so that they present a lustrous, bright copper appearance, they are removed from the copper basket, thoroughly rinsed off in cold water and then placed in the nickel basket.

These baskets have a door or lid in one end, through which they are loaded, standing the basket on one end and pouring the work in through a large funnel made for the purpose. Then the door is locked and the basket put in place. It is often desirable to see how the work is progressing. For this purpose a long handled dipper or large spoon is used. Stop the basket, remove the door and dip out the work to be examined.

These baskets are made up in different ways of perforated wood, of rubber or rattan. The latter seems to be in most general use and gives good satisfaction. The baskets are wired back and forth; the wires being inside and running from end to end and only a few inches apart. This is to give the work connection with the negative pole of the dynamo, the wires all running to the brass axle at either end of the basket and being securely soft soldered to it to insure a perfect connection; the brass axles running in brass collars on either side of the tank, to which is connected the negative pole of the dynamo.

While these plants can be and are successfully run, anyone contemplating putting in such a plant would do well to secure the services of a specialist to fit up and start the plant, as it is a little out of the ordinary way of plating. Many platers are unable to operate them successfully, owing principally to the fact that they do not use suitable solutions. Ordinary solutions are of no value with the basket process, as for this work solutions must be supplied with all the metal they will take up. (See formula.) This is true with copper and nickel, but the reverse is the case with silver; the work to be silvered first being coppered, a weak silver solution will suffice, as only a thin film is usually required.

Up to the present time it seems that no one using this process has been able to use it successfully in a solution where two or more metals are in combination, such as brass or bronze. To overcome this difficulty the work is first coppered, getting the bright, burnished finish, then put into buckets of cold water, dipped out into large wire baskets made for this purpose and plated for a few minutes in the bronze or brass solution, shaking and stirring the work often, so that all parts are colored alike. Then the work is quickly removed, dried and lacquered. This brassing or gilding process, as it is called, should be quickly done, as if any considerable plate is deposited it will spoil the brilliancy of the finish.

COPPER PLATING BY THE REVOLVING BASKET PROCESS.—Cyanide solution is made dense in metal, so as to register 30° B. Copper anodes are suspended on each side of the basket for its full length and about four inches away from it.

For lead and soft metal the basket is allowed to stand in the solution until the articles to be plated get a covering of copper. The basket may then be started in motion. The rolling consists of turning four times in eight seconds and stopping for the same length of time and this kept up until the work is rolled up to a bright copper.

The rolling and stop motion is obtained by what is known as a revolving washing machine hanger.

For articles made of lead and soft metal it will take from one and one-half to two hours to obtain the bright finish.

Hard metal, such as iron, steel, zinc, etc., may be started rolling as soon as the basket is put in the solution and will take from one-half to one hour to give it the bright finish.

Nickel Plating by Revolving Basket Process.—Nickel solution is made up of the double sulphate of nickel and ammonium salts, as much as the water will take up, with the addition of one-half pound muriate of ammonia or one-half pound common salt to the gallon. Nickel anodes should be suspended the entire length of the basket and four inches away from it.

As soon as the work is put in the solution the stop motion is applied, and it takes from one-half hour to one and one-half hours to give the work a bright, buffed finish.

For revolving basket plating it requires a dynamo current strength of at least seven volts, as the connection in the work is very poor and frequently broken by tumbling.

The most economical size of the basket for this work is: Diameter, fourteen inches; length, twenty-eight to thirty-six inches. Baskets of a greater diameter break up quickly, and smaller ones have not got the rolling power.

The latest improved method for plating this class of goods consists of a wooden tub about twenty-four inches deep, eighteen inches in diameter at bottom and twenty-four inches in diameter at top. These tubs revolve on an iron pedestal at about forty-five degrees. The bottom of the tub is of metal, usually copper. This furnishes the cathode connection for the work being plated, the metal bottom having a copper strip pressing against it in the form of a spring as the tub revolves. This spring is connected with the cathode wire or negative pole of dynamo. The anode or positive pole is brought along overhead with a perpendicular wire connected over each tub to which the anode is attached. Just enough solution is put in the tub to nicely cover the work. The anode is allowed to hang into the solution as deep as possible without touching the work. The advantages of this system are the ease with which the work is handled, always having the work in sight while plating, economy of floor space, cleanliness and increased output. This system is handled much the same as the one previously described. The solution used mostly in this machine is the copper solution. The work is then usually finished in brass, bronze or silver in the wire baskets recently referred to.

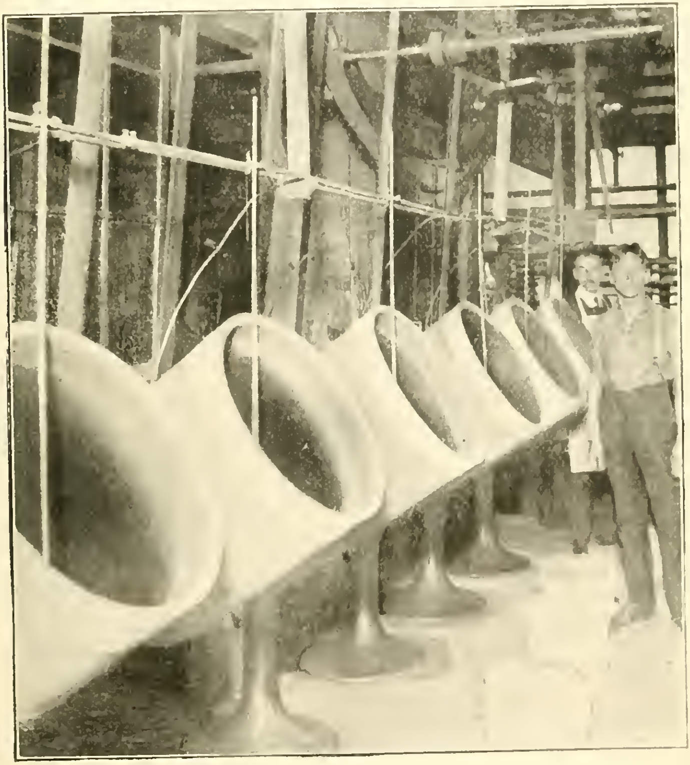

Fig. 75.

CHAPTER XV.

FINISHING PLATED GOODS.

Burnishing.—Burnishing is for the purpose of producing a smooth, hard and highly polished surface upon plated articles of gold and silver without removing any of the plate. Methods are now in use for doing away with burnishing on the cheaper classes of work by having the articles highly polished before plating; then plated with a slow and steady current, getting a hard close-grained deposit; then buffing the goods afterwards. This plan, no matter how carefully done, is only suitable for cheap work, as the buff removes more or less of the plate and in the case of soft metals considerable of the plate is removed before the desired finish is obtained. For first-class wearing qualities in silverware and cutlery it is still necessary that the goods be burnished. As proof of this, if the plater will investigate any of the large silver plating concerns in the east where flat ware is manufactured, it will be found that all bright parts are still burnished, either by hand or on the burnishing lathe. Burnishing polishes the plate down hard upon the base metal, filling up small scratches and other defects and closing the pores in the plate, thereby making it smooth, very hard and consequently more durable.

This work is usually lightly buffed with soft buffs and powdered rouge to remove any burnish marks that may remain and to even up the surface, but this operation removes very little of the plate, as it has already been made hard and smooth by the burnisher.

Extra precaution is necessary in plating goods that are to be burnished; it must be a firm and adhesive deposit to

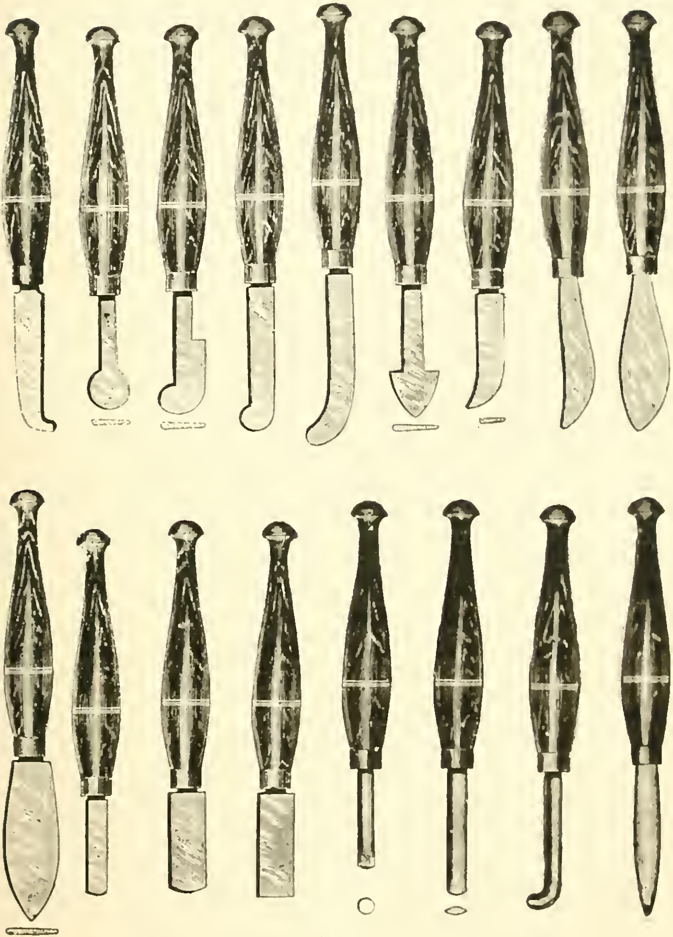

Fig. 75. Shapes of Burnishers.

prevent blistering or peeling up under the pressure of the burnishing tool.

Hollow ware is usually burnished in the lathe upon wooden chucks made to fit the article, using long handled tools of steel or blood stone, with soap suds as a lubricant. All parts but handles, legs and spouts may be burnished in the lathe, which is much quicker than hand work. The projecting parts are afterwards burnished by hand.

It takes considerable time and experience to become a skilled burnisher, either on the lathe or by hand. Hand burnishing looks easy, but, like everything else, it takes time and patience to become proficient. To the beginner it is both hard and tiresome work.

In preparing for hand burnishing the first thing is to secure as good a light as possible. The work should be done on a stationary table which will be a little above the waist of the operator when seated. To this bench should be nailed a board about six inches wide and projecting out from the bench about six to eight inches. This is called the burnishing peg and gives the operator free use of his arms in burnishing, which is essential. Over the projecting peg or board is wound a cotton cloth tacked upon the underside to prevent the work from being scratched. A piece of thick leather (walrus is preferable if obtainable) should be tacked to the bench on the right of the burnisher and near the peg, so as to be convenient for use without getting up. Grooves should be cut across this leather. Into one of these put a little flour emery and oil; in another powdered crocus or rouge; in a third putty powder or Vienna lime may be used. These are for polishing and brightening the tools, keeping them in perfect condition. The emery should be used first and the tool wiped off before using each succeeding groove. Now with a bowl of soap water, made by two or three slices of laundry soap left in the bowl of water over night, and a clean, soft cotton cloth, you are ready to begin burnishing.

The tool is grasped close to the blade with the right hand, the end of the handle resting against the left breast of the operator. The tool being held tightly against the breast, it works as a sort of pivot or hinge as the tool is being swept back and forth, keeping it firm and in the proper position. Professional burnishers in large silverware factories use a brass plate an eighth of an inch thick, with a number of small holes or dents in it to act as sockets for the end of the handle. This plate is held on the breast by a cord around the neck and serves to distribute the pressure over the chest and protect the clothing. The tool should be kept wet with the soap water, and swung back and forth on the article with an even pressure, each succeeding stroke lapping over the last one so as not to leave unburnished streaks. Care must be taken to keep the tool from scratching or cutting into the plate. If it scratches the work, it should be vigorously polished upon the leather. Sometimes a tool may be too soft, or have soft spots, which will cause the scratches.

The work should be thoroughly freed from grease before burnishing. This is best accomplished by using wet, white, sea sand and then rinsing well to remove all sand. If the work burnishes streaked, or with dark marks caused by grease, a spoonful of potash may be added to the soap water.

Burnishing tools have two edges, one sharp and one blunt. The sharp edge is used for the first operation or "cutting down," finishing with the blunt edge when it is necessary to go over the surface twice.

Experienced burnishers are able to get an even surface and high finish with a single operation, and by going over the article a second time not a line or mark is visible, so perfect is the finish. It takes a long time to become proficient in this work.

Burnishers are of two kinds, steel and bloodstone. The steel tools are in most common use, especially for hand use, being much cheaper than bloodstone. Bloodstone or agate burnishers are expensive, costing from $2.00 up; moreover, they are fragile, being apt to chip or crack if allowed to fall, or hit against any hard object. They are used chiefly as finishers by lathe burnishers and for going over the work a second time. They impart a very high polish and bright luster.

Steel burnishers are in general use for all classes of work.

The two main objects should be first to get a good grade of fine grained steel of which to make the tools; the next is to have them properly tempered so that they will be hard throughout. It is a difficult matter to temper burnishing tools properly and it should be done by a mechanic that understands tempering steel tools. If they are too soft they will cut and scratch the plate; if too hard, the tool is liable to crack. It is usually better to buy these tools from a dealer, as they can be had in any shape desired.

Sand Blasts.—Sand blasts are constructed in several different styles, the main object being to have a sufficient driving force, either steam or air, and also to have the sand box constructed so that the machine will be self acting, that is, so that it will work continuously when the air or steam is turned on. If the bottom of the box is given the proper slant and is lined with zinc or tin, when the pressure is turned on there will be a continuous flow of sand. These machines are extensively used in silver shops for getting a dead matte finish, which is difficult to obtain with a satin finish wheel, also for French gray work on silver. After the piece has been oxidized and rubbed down it is then sand blasted, which brings out that dull, dark finish usually called French gray.

Jewelers (manufacturing) also use the sand blast for matting and satin finishing work. Rings, lockets and other things which are to be Roman colored are usually sand blasted first. The advantage of this in the jewelry shop is that it will satin finish inside and outside alike and in close and narrow places where it would be impossible to get with a satin finish wheel. The finish is uniform and even, and where a good pressure is obtainable the work is rapidly done. A pressure of air is the proper force for the sand blast in the silver or jewelry shop, as steam causes the sand to become wet and clog, thus hindering the work. Different grades of sand or quartz may be used, according to the finish desired, whether rough or fine. A brilliant finish on soft metals, such as gold and silver, is obtained by using powdered glass instead of sand. To powder the glass, heat glass scraps until red; then drop in a pail of very cold water; grade the powder carefully, as the evenness of the finish depends on it.

The sand blast is very serviceable as an adjunct to polishing on brazed work, such as bicycle parts. The surplus brass may be removed by sand blasting, using a steam pressure. It will also smoothen and remove scratches from iron and steel, thus reducing the labor of polishing. The sand blast should be provided with a controlling valve in the air or steam pipe, so that the pressure may be increased or reduced at will. The top of the sand blast box should also be provided with a window set in so that the operator may see at all times just how the work is progressing. The inside of the sand box being dark, an incandescent lamp is very useful to have hanging above the glass in the top of the sand blast. In this way it is easy to see how the work is progressing

For details as to buffing plated work see the chapters on polishing, as these matters were thoroughly covered there.

CHAPTER XVI.

OXIDIZING AND COLORING PLATED WORK.

By "oxidizing" in the plating shop is meant the surface coloring of metal goods of either silver, copper or brass. This is usually for the purpose of imitating the finish upon old metal objects that have become oxidized by age and constant exposure to the air. Or it may be the object in oxidizing goods, especially of copper, to bring out those soft, restful shades known to the trade as statuary bronze.

While oxidizing, strictly speaking, cannot be considered as electro-plating, still it is a very important adjunct to the plating business and could not be left out of consideration by anyone contemplating a start in the plating business. Of late years the amount of chemical finishes and the vast range of goods to which they are applied is steadily on the increase. These finishes usually give better satisfaction than the bright or plain metal finishes, hold their color better and are not so apt to tarnish or discolor.

Silver plated goods to be oxidized in the following solutions should be plated quite heavy, at least as heavy as an ordinary double plate. If the silver plate is very light, the chemicals in the dip are liable to remove the silver from the base metal and the object would have to be replated. If the plate is very light, it will be rubbed or polished off in finishing the oxidized article, in which case it usually has to be replated, first removing the oxidized finish.

Black Dip.—For silver plate or sterling silver:

Water	1 qt.
Liver of sulphur (sulphurette of potassium)	6 oz.
Ammonia	1 oz.

Add the liver of sulphur to the water; heat almost to the boiling point; then add the ammonia. Use hot.

The silver goods must be just as clean for this operation as for plating and should be sanded or scratch-brushed wet, using soap wood bark or stale beer for scratch brushing, then potash the article and rinse in clean water before immersing in the hot dip. Then hang in the dip, moving gently so as to have all parts colored uniformly. When it has become black all over, remove, rinse in cold and then in hot water and dry in sawdust. Then scratch brush (dry), after which it is to be finished and rubbed up by hand with fine pumice stone dampened, washed out again, dried and lacquered. It is not necessary to dry and scratch brush the article after oxidizing if it is to be rubbed with pumice to receive its finish, but it may be rubbed with the pumice directly from the rinsing water. The object in first dry brushing is to see that the oxidize is uniform and adheres well before proceeding to finish it.

Care must be taken not to handle work to be oxidized after cleaning it. It must be wired as for plating, as the finger marks upon the silver would prevent the chemicals of the dip from acting on the metal evenly and properly. The same care is required in handling the goods after oxidizing. The hands should be dry and clean, to prevent leaving finger marks. Oil or grease must absolutely be kept from this work, as it will ruin it if allowed to come in contact with it.

The oxidizing solution should not be allowed to get into the water vats, either hot or cold, in which the plated work is being handled, as it is liable to cause trouble by tarnishing or oxidizing the work. This solution must be hot for silver oxidizing and works best when fresh.

To remove this finish from silver, place the goods in a strong solution of cyanide of potassium. If this does not act rapidly enough, heat it and the oxidizing will soon be removed.

In oxidizing large objects which are too large to immerse, or which require to be oxidized in places and not all over, the object should be gently heated over an alcohol lamp, or any other convenient way, and the solution applied with a stiff brush or a stick with a rag wound around the end. Keep applying the oxidizing solution and heating the object until a uniform black is obtained, but more than enough to blacken the surface must not be applied, as in case too much is put on it will peel off similar to an electro plate. In that case the finish will have to be removed by cyanide, as above described, and unless the article has been heavily plated before oxidizing, it may require replating before it can be reoxidized, as the staining caused by the chemicals seems to penetrate into the more or less porous silver plate, so that when it is removed part of the silver plate is also removed.

To remove spots and stains which are bound to get upon the work being oxidized where it is not wanted, wet a rag or sponge with strong cyanide solution and apply to the parts and all stains will be quickly removed. The cyanide itself must be immediately removed by rinsing in clean water, as otherwise it would attack the silver, leaving it streaked and spotted. If left on the plate any great length of time the cyanide will dissolve part of the plate.

There are several different ways of finishing the article, after it has been oxidized, besides the one referred to in the beginning of this chapter. If the oxidized article is evenly brushed with a soft brass wire scratch wheel (an old one well worn down is best), a very beautiful black is obtained, which is sometimes called gun metal. This finish should be lacquered at once, as it is affected by finger marks and by the air, if left standing any length of time without lacquering. To produce that very highly polished steel black finish on silver plated goods the article is first rouge buffed, getting a high finish and taking particular care not to leave any rouge dirt from wheel or finger marks upon the work.

Then wire and dip immediately into hot oxidize solution. Then rinse in clean cold, then warm, water and buff up at once before they become dry, as if they become dry they are liable to show water streaks and stains. Great care and skill is required in getting a high finish on this class of work, as the oxidize is very easily cut through. It is usually handled the same as silver plate, cleaning out the buff well first with an old file or nails driven through a stick for the purpose, using very little lamp black mixed with alcohol and water and a light pressure.

Another finish which is used considerably, upon plain surfaces, such as plates, rods, and other articles in the hardware line, is obtained by oxidizing the object black, as before described, and then rubbing the article *all one way* with wet powdered pumice stone, using the palm of the hand or finger. A piece of felt may sometimes be used for the rubbing. The black should all be removed by rubbing evenly until the desired shade of gray is obtained.

Another way is to use a small felt wheel, with a knife edge, for removing the black and exposing the silver, either in straight lines or zigzag scrolls. A little hard rouge or buffing composition should be applied to the edge of the wheel to make it cut readily.

GREEN ON SILVER.—The light green shade seen in the flower and filigree work on silver plate used extensively on coffin hardware of the better class and known as French gray in this line of business, is produced by using a very old liver of sulphur dip in a weakened condition and just hot enough to bear the hand into, using plenty of liquid ammonia. Immerse the work, watch closely and remove and rinse the instant the green shade appears and rub off high lights with wet pumice.

Still another method is to remove the color where desired by the use of very strong cyanide of potassium, applied with a sharp stick or tooth pick.

Platinum Black or Gray on Silver.—For the higher grades of silver plate and sterling silver a solution of platinum is very often used, where the surface is not so large as to make the operation too expensive, as the platinum costs considerable as compared to some of the other dips. Still, a very little of it goes a long way. This solution is always applied with a small brush to the parts of the article which are to be oxidized. The article is heated and then the platinum is applied. If it does not turn black, at once, it should be heated again. This preparation is used mostly on sterling silver pieces that have been etched to give the proper tone or shade to the letters; also where the rim or the flowers on the edge of a dish or vase are to be oxidized. It is also used in antiquing sterling silver, jewelry and novelties, such as ladies' bag frames, buckles and the like.

After applying and getting the surface to be colored uniformly coated, it is rinsed and treated with pumice stone and the scratch brush to get the desired effect. This finish will withstand the action of the air very well; therefore it will not be necessary to lacquer it, but a coat of lacquer will improve its appearance and at the same time protect the plain parts of the silver from tarnishing.

To prepare this solution it is necessary to use an evaporating dish, so that the acid may be heated. Put into the dish any scraps of platinum you may be able to obtain. From one-half pennyweight to one pennyweight will be sufficient to make considerable of the solution. The platinum wires from old incandescent light globes will do if they can be obtained. It must be remembered that platinum is very expensive, being about on a par with fine gold. After putting the platinum in the dish, add one ounce of muriatic acid and one-half ounce of nitric acid. Both should be C. P. Then gradually heat the dish. The more heat applied the more vigorous will be the action of the acid upon the platinum. The dish should be kept hot until the acid has been reduced by evaporation to one-fifth its original volume, or until it has a dark red color and the consistency of thin syrup. The platinum may not be all dissolved; this is not necessary, as platinum is very hard to dissolve. When the acid is sufficiently reduced in volume by heat, the dish should be allowed to cool. After cooling add one-third its volume of alcohol. Then bottle for use, saving any scraps of platinum that may be left for the next occasion.

Care must be taken in preparing this platinum solution (called chloride of platinum) not to inhale fumes, which are very injurious to the health. The work should be done where there is good ventilation, or in the open air. Great care should be taken to use the acids in proper proportions, using two parts of muriatic to one part of nitric, otherwise the work of dissolving the metal will be slow and unsatisfactory.

IRON BLACK OR GRAY ON SILVER.—Another solution which is often used upon artistic pieces of silver and which is greatly admired by lovers of antique finishes, is made exactly the same as the platinum, with the exception of substituting sulphate of iron for the scraps of platinum. Take about an ounce of sulphate of iron (crystals). Reduce it in the evaporating dish with muriatic and nitric acids, using rather more acid than for platinum. When the iron is cut up, evaporate to one-fifth its volume, allow to cool and add one-third its volume of alcohol. Bottle for use and apply this with a brush. In using this solution the article will not require heating, as it will act upon the metal very readily. When cold this preparation gives the work a beautiful dark brown or black color, tinged with red. By heating the article a red sediment will be formed in the hollows and crevices, then the high lights being rubbed off with pumice stone gives the finished article a beautiful effect. This preparation in many instances takes the place of platinum, as with a little care almost any shade may be obtained which is obtained with platinum. Besides the red cast obtained by heating which is peculiarly its own, it has still a greater advantage of being inexpensive.

Cheap Black on Silver.—For blackening or oxidizing backgrounds of chased work, leaves, trees, or figures, such as are seen in imported silver goods, especially those of German manufacture, a preparation of lamp black is used moistened with water and applied to the article with a stiff brush (an old tooth brush is handy). Allow the color to dry; then remove the black from the exposed parts with a damp cloth; finish with a dry cloth by rubbing briskly. This gives a very handsome finish upon some goods and is the proper thing upon goods supposed to have been made several hundred years ago, or for imitations of such goods. If properly dried and finished up this will not rub off and gives good satisfaction.

A preparation called "Lampenswartz" may be purchased at any artists' supply store, which is very cheap and greatly excells that made by mixing the lampblack and water. It is made in Germany and is ready for use, being put up in small bottles. To the trade this finish is known as "Turkish Oxidize."

French Gray, or Oxidizing Cheap Work.—For oxidizing cheap silver plate, where black or very dark color is not required, and where the silver plate will not stand much rubbing in the finishing process, the following preparation is used:

Granulated sal ammoniac	6 oz.
Sulphate of copper	6 oz.
Salt petre (nitrate of potash)	6 oz.
Boiling water	1 qt.

It gives the best results and darker shades by using it hot, but works very well cold, the shades becoming darker upon being exposed to the air. This preparation may be used for a long time by simply adding the ingredients in proper proportion from time to time according to the amount of work which is being oxidized. This solution is used extensively for getting French gray finishes, especially upon cheap goods which will be described under the proper heading.

FRENCH GRAY ON SILVER.—This finish, which is being extensively used upon fine silverware, both plate and sterling, is produced in different ways according to the shade desired. Whatever the shade or finish, it is necessary that the object first be oxidized as for oxidized silver. Then the gray finish is brought out afterwards by the use of pumice stone, and hand brush, the scratch brush or the sand blast, as the case may require. To produce a dark shade of French gray the object should be oxidized in the liver of sulphur and ammonia solution previously described; then it should be brushed with a stiff hand brush and pumice stone with water, brushing the object all one way as much as possible, so that the lines may be straight and uniform. The oxidizing should be entirely removed from the plain parts of the piece, being allowed to remain in the background, or filligree work. Then the piece is washed and dried in sawdust, allowing no streaks or tarnish to remain upon the work. It should then be sand blasted evenly all over, washed out and lacquered. Where the sand blast is not available the object may be evenly satin finished upon the steel satin finish wheel.

There are other processes after sand blasting to get certain shades. For instance, if a softer, duller hue is desired than is left by the sand blast, the object may be scratch brushed evenly with an old and soft brass wire scratch wheel, either wet or dry. Or, after sandblasting, the high lights or edges may be relieved by polishing all high parts on a Spanish felt wheel with tripoli, finishing with rouge, and then washed out, dried and lacquered. This gives a beautiful finish and is used extensively upon toilet sets, in finishing the backs of mirrors, brushes, combs, powder boxes, etc. The high parts may also be relieved or brightened by the use of pumice stone applied wet, with the hand.

Very striking effects may be obtained in French gray by using the platinum solution; also the chloride of iron dip previously given, especially upon artistic designs where heads, flowers or figures of animals form the ornaments. The same methods are employed as just described, the sand blast being the most important essential in French gray finishing, the other appliances and operations being mere accessories to get the desired shade.

The sal ammoniac and sulphate of copper dip previously described is used extensively upon cheap work, as it does not attack the silver and is easily removed with a little rubbing, consequently it may be applied to a very light silver plate. In using this formula a very nice effect may also be obtained without the use of the sand blast, simply by the use of a hand brush and pumice stone and finishing with the hand brush, brushing all one way until the color is sufficiently removed to get the desired effect. Or it may be given a final finish by the use of the scratch brush, wet or dry, then dried and lacquered.

It is a very common practice (and a good one, too) in factories where cheap toilet and novelty goods are manufactured, to nickel plate all goods before silvering, especially those to be French gray or oxidized. Then if in the operation of finishing, the silver is worn through, as is often the case, it will not be noticeable. This practice greatly reduces the amount of silver required in the plating of cheap work.

Black Nickel, sometimes called "gun metal" solution, should be classed with the oxidizing dips. While it is applicable to all classes of metal goods, whether plated or not, it will be given here in full and referred to under other heads as the occasion requires. This is used to a great extent for getting French gray and gun metal finishes. Strictly speaking, it is not an oxidizing solution, but a plating solution, as the current must be used to get results. The formula follows:

Nickel solution	1 gal.
Carbonate of ammonia	3 oz.
Ammonia	1 pt.
White arsenic	1 oz.

C. P. Cyanide enough to make the solution clear.

Pulverize the carbonate of ammonia; then dissolve it in the nickel solution. Next add the ammonia. Now dissolve the arsenic in a small quantity of the solution; when made into a thin paste add it to the solution. Add the cyanide last, using enough to clear up the solution. It should be about the color of dark vinegar. After thoroughly mixing, it is ready for use, using a nickel anode and not too strong a current. If the black deposit is streaked or spotted, remove the object and scratch brush; then replate, using a little more current. If too much current is used the work is liable to come from the solution a dirty gray black. The anode in this solution must be kept clean to obtain the best results. After the solution has been used for sometime the deposit may be off color. In this case add a little more arsenic. This deposit may be applied to silver to be finished as any other French gray, but being an electro deposit, instead of a dip, it may also be finished on the buff, or with the burnisher. It is very often used on goods requiring a black or gun metal finish. After being removed from the black nickel solution, the goods are finished on the scratch brush or buff. In this case the goods do not need any previous plating of silver, but the gun metal or black nickel is deposited directly upon the base metal.

A cheap method of oxidizing silver is by the use of chloride of antimony, or butter of antimony, applied by a small brush to the parts to be oxidized, heating the article gently and then wiping dry with a cloth or drying in saw dust before rubbing or finishing with the pumice stone.

This is only recommended for cheap work and it should be quickly lacquered after finishing. Use little or no heat in drying the lacquer, as much heat will change the color of the finish. A very good imitation of platinum oxidize at one-half the cost may be obtained by making platinum oxidize and sulphate of iron oxidize in equal parts and mixing the two solutions. The result will be hard to distinguish from the pure platinum oxidize.

There is probably no other branch of the electro-plating business, except possibly gilding and rose gold plating, that requires more skill and artistic taste in the operator than oxidizing and the French gray finishes, especially where the operator is compelled to match samples of which, perhaps, he has no knowledge of how the finish is obtained and no way to find out, so that he must rely entirely upon his own skill and judgment. Very often in shops where jobbing is done, articles come in to be repaired and soldered. Of course hard soldering removes the finish and to be able to produce the same finish the plater must see the object before it is put through the fire in the soldering operation and then retain in his mind just how it should look and how the finish was obtained if possible. Then try to reproduce the same result.

Oxidizing of any kind cannot well be patched up. That is, in case of a bad spot, or flaw, or peeling up of the color of whatever kind, it is usually better and cheaper to remove the color and refinish the whole thing, rather than try to doctor up the bad spot. It very seldom if ever gives satisfaction to try to patch such work.

Butler Finish upon Silver.—This is obtained first by evenly rubbing the surface with wet powdered pumice, then rinsing and scratch brushing on a well worn but smooth brass wire wheel, either dry or wet. The uniform white finish upon silver ware is produced by using a wide brush (circular scratch brush), either bristle or wire, but the brush should be well worn and even to get the best results. Brush the work all one way as much as possible, using finely powdered pumice stone and water on the brush and work, applying both freely. Flour of emery may be used to obtain a very nice butler finish, being dampened with water and applied by hand, rubbing gently in one direction until the desired result is obtained.

The most delicate and handsome butler finish is obtained by using flour of emery mixed with olive oil to a thick paste and applied to the piece with the tips of the fingers, or the palm of the hand, keeping the lines uniformly in one direction. This gives a soft, velvety finish obtainable in no other way. When the work is properly finished, it should be thoroughly washed out with strong hot soap water to which a little ammonia has been added, then dried with clean cloth or sawdust and lacquered.

To Fill Letters.—For filling in monograms and lettering upon silver where they are required to be black what is known to the trade as heelball is used, moistened with oil, and then rubbed over the letters until they are filled with black. The article is then wiped clean with a cloth or towel. If the heelball is not obtainable, a mixture of lampblack and beeswax, melted together, may be used with satisfactory results.

Oxidized Copper.—For oxidizing copper or copper plated articles of any description the formula in most general use is composed of:

Liver of sulphur (sulphurette of potassium)	3 oz.
Ammonia	1 oz.
Water	1 gal.

This solution may be used warm or cold, as best suits your requirements, though it is usually used cold. It also works very well without the use of ammonia and the amount of liver of sulphur may be reduced or increased as best suits the case of each individual operator. It will be found that by practice and careful manipulation a great many shades and colors may be obtained from this solution. But I wish to caution those not familiar with this solution not to use it too strong in sulphur on copper work, as in such a case it is very apt to peel off, and if the copper plate is light it will remove the plate also. If the solution is strong it is best to use it cold. Some advantage may be obtained by heating slightly a solution weak in sulphur, as this will hasten the process.

Mahogany Red is obtained by first plating the object in a duplex copper solution, scratch brush, have thoroughly clean, dip quickly into a very weak solution of liver of sulphur, remove and rinse in cold water only, as hot water will change the color. The proper shade is a mottled brown streaked with a fiery red, also with patches of almost black with a little blue mixed in. When the desired color is obtained dry with a clean cloth or dip in lacquer thinner, to remove water, and lacquer at once. The lacquer will usually remove the blue tints which are not desirable. If the first operation is not successful dip in cyanide and repeat.

Just enough should be prepared at a time for the requirements of the day, as the solution loses its strength rapidly and is best when made fresh every day.

By using from one to three pennyweights of the liver of sulphur in a gallon of water, a golden yellow or straw color may be obtained; by increasing the amount the shade runs into a mottled brown, which when scratch brushed with a soft brass wire brush brings out a beautiful chocolate color, known as statuary bronze. The shades of this also run from light brown to dark brown and finally into black.

Dry scratch brushing is best suited to bring out the color and insure a high finish. If the article be dry scratch brushed several times it will give better results than just once.

Different effects may also be obtained by oxidizing the articles to the shade desired and then rinsing in clean water and rubbing with powdered pumice stone (wet), either with the fingers or with a piece of Spanish felt.

Other results are obtained by oxidizing the article black; dry off; scratch brush or rub off the surplus black with a clean rag, or dry scratch brush; then the object may be relieved in places by the use of a clean narrow buff, to which wet pumice is applied. Or it may be buffed off in places, as the taste of the operator suggests, with the buff and rouge or buffing cake. Still another way is to spot the article with the corner or edge of a felt wheel. But in each instance the operator must be the judge of the style of finish best suited to the work in hand.

A very nice dead black finish may be obtained by oxidizing the article black in quite a strong solution; then rinse and dry in sawdust, wipe off gently and lacquer.

For oxidizing highly polished copper or copper plated articles that require a bright finish or bright colors, a solution is used which is composed of

Hyposulphate of soda	4 oz.
Sugar of lead	4 oz.
Hot water	1 gal.

The solution should be well stirred up before using and should be used hot, near the boiling point. This solution also must be made fresh for each day's operation.

The work must be highly polished to obtain the best results, that is, after copper plating. It should then be thoroughly cleaned with a soft brush and potash, rinsed and dipped into the hot solution. When the desired shade is obtained, rinse, dry in hot sawdust and lacquer.

Nearly all the colors of the rainbow may be obtained from this solution. The colors start in with a light yellow, running into gold, orange, wine color, purple, blue, very light blue, then into a grayish white. The objects should be agitated while in the solution and must be raised occasionally so that the operator may judge when he has obtained the proper shade. The work will change rapidly from one color to another, so that a careful watch must be kept and the piece removed the moment the color is suitable.

VERDE ANTIQUE BRONZE.—For antique bronzes requiring that ancient appearance usually produced upon bronze goods by exposure to the atmosphere for many years, the following solution will be found valuable:

Sulphate of copper	½ lb.
Sal ammoniac	½ lb.
Water	3 pts.

This solution should be used very hot. After the copper and sal ammoniac have been all dissolved the solution should be heated nearly to the boiling point and the object to be oxidized should be immersed while the solution is kept hot. It should be allowed to remain from three to four minutes in the dip, moving occasionally so that the oxidizing may cover the object evenly. When the work takes on a black color all over it should be removed and dried off by heating. If it comes out properly, the object will be found to have a deposit of verdigris in all corners and crevices. This is known to the trade as the verde antique finish. The hands should now be moistened with a little linseed or olive oil, not using enough to make the fingers too oily, just enough so that it is perceptible. Then take the object in the hands and proceed to finish by rubbing gently all high and exposed parts until the whole takes on a beautiful glossy black appearance which is set off by the verdigris in the background. The grade of the metal to be antiqued will have much to do with the finish obtained, as objects made of brass will be more readily oxidized than objects made of copper.

It is sometimes desired to expose the metal itself in places. To do this it is only necessary to use a little more pressure with the fingers in finishing those parts where you desire to expose the metal. Usually this finish is not lacquered, as the color and finish are usually improved by age.

Places which have been soft soldered, or holes which have been filled with lead, must first be copper plated before the object can be finished in verde antique.

A more pronounced black may be obtained and the results obtained more quickly by using

Sulphate of copper	4 oz.
Sal ammoniac	4 oz.
Vinegar	1 pt.

Use hot.

A soft brown color may be obtained upon copper by brushing the surface with a mixture composed of

Plumbago	½ oz.
Ferric oxide	½ oz.

Alcohol sufficient to make a paste.

Brush the object over evenly; then heat. When the article becomes warm and thoroughly dry, brush off the powder and polish the surface with a chamois skin. Then lacquer. The shade of this color may be somewhat regulated by the amount of heat being used; the more heat applied, the darker will be the finish.

Royal Copper.—Royal copper is the process of covering the article to be royal coppered with a film of lead by electroplating in a lead solution. The article is then placed in a retort and heated until the lead is decomposed. Then the article is removed and polished. Or the article, which must be of copper, is first highly polished, then coated with a mixture of white lead and alcohol put on evenly all over, then put into the retort and heat until the object has become red all over and the lead covering is burned to a yellow crust or powder; upon cooling remove, brush off the lead oxide and polish on a soft small buff.

ANTIQUE BRASS.—Brass is one of the most, if not the most, difficult metal upon which to produce the desired shades and colors in oxidizing. Owing to the presence of zinc, with which the copper is alloyed to produce brass, it is difficult to get the more common solutions that work well on copper to have any effect on brass. For instance, copper is readily oxidized by a weak solution of liver of sulphur, used cold, while liver of sulphur has no desirable effect upon brass using it either weak or strong, hot or cold. Further on it will be described how the brass may first be treated with a film of nitrate of mercury and then oxidized the same as silver or copper.

People have very different ideas as to what an oxidize finish is and what an antique finish is. Some make the proper distinction; some make none at all; others know none. They simply see the color and finish. It looks the same to them, whether called oxidized brass or antique brass.

But to the trade anything that is blackened or colored in the ground work of background, buffed on the high lights and given a bright finish is usually called oxidized brass. If the same article has the coloring or oxidizing removed by wet pumice stone with the use of the hand brush and finishing by rubbing with the hands, giving an old and dull appearance to the brass on the raised parts, it would be called antique brass.

Some of the oxidizing solutions given for copper are suitable for brass, but not all, owing to the presence of zinc in the brass. A very brilliant and lustrous black may be obtained upon polished brass goods by immersing in the following:

Verdigris	½ lb.
Ammonia	1 qt.

Dissolve the verdigris in the ammonia and use hot, dipping the well cleaned brass articles into the solution until they become black; then remove; rinse; dry in hot water and sawdust.

The solution in most general use for oxidizing brass goods, requiring a steel gray or black finish and which, being an electro deposit, may be buffed or polished, is as follows:

Muriatic acid	1 gal.
Arsenious acid	4 oz.
Iron filings	4 oz.

Add the arsenic and iron fillings to the muriatic acid.

This solution must be used with the electric current, using an old file or any clean piece of steel for an anode. A weak current should be used and this solution must be kept absolutely free from water, so the work, before being placed in the solution, should be well freed from water by shaking or drying with a clean cloth.

Lilac Dip for Brass.—

Butter of antimony	6 oz.
Muriatic acid	8 oz.
Arsenious acid	1 oz
Water	5 gal.

Black on Brass.—Coat the brass articles thoroughly with a solution of nitrate of mercury. Then dip in a hot solution of liver of sulphur. The article should be oxidized quickly in a quite hot and strong dip, as the white film is quickly absorbed by the dip and if allowed to remain too long in the dip it will peel off. Cut down the mercury with sufficient nitric acid. Then add to this a solution of cyanide and water.

A very beautiful bright black is obtained upon bright brass articles by using the following dip:

Muriatic acid	8 oz.
Arsenious acid	2 oz.
Chloride of antimony	1½ oz.

No water should be allowed to get into this dip. The work should be thoroughly cleaned and dried and then dipped into the dip for a few moments. It may be wiped off or scratch-brushed on a soft wheel and the operation repeated several times till the color is satisfactory. If this solution is used hot it will give better results. By the addition of one and one-half ounces of sulphate of iron to the above the finish will be of a blue-black shade.

The following will give a grayish steel color, and by repeated dippings a blue-black on brass. It may be used hot or cold, but works best hot:

Water	10 parts.
Muriatic acid	2 parts.
Sulphuric acid	1 part.
Arsenious acid	1 part.

Brown black on brass:

Muriatic acid	1 gal.
Carbonate iron	2 oz.
Arsenious acid	1 lb.

Blue black on brass:

Muriatic acid	1 gal.
Sulphate iron	2 oz.
Arsenious acid	1 lb.

The solutions can be used without current, but work best with current, using steel anode.

The great trouble with many formulas given for oxidizing, especially on brass, is that they give very unsatisfactory results, often producing no color whatever. Of course much depends upon the quality of the chemicals used and more upon the operator himself, and the way he prepares his dip or solution and the way he handles his work. These formulas have all been in practical use and are known to give good results if properly handled.

OXIDIZED GOLD FINISHES.—These are applicable to statuettes, clock cases, novelties, chandelier and ornamental metal goods. These finishes are thoroughly practical, in use every day and not found in books. As you, of course, are aware, gold is not easy of oxidization. In fact it is known as the metal which is the least easily tarnished or oxidized. But it has this advantage, that when the oxidization is worn off a gold plate remains, whereas in other finishes on copper, etc., usually when the oxide is worn off the base metal shows, from the fact that all durable oxides depend on the reduction of the metal to a sulphide, and if plated it is apt to leave the deposit very thin when the job is finished (oxidized). The fashion at the present time is to oxidize gold. In fact, very little clean, yellow gold leaves the shops, and it seems as though the more tarnished or corroded the job is the better or more artistic the finish is considered to be. Oxidizing gold is usually made applicable to ornamental goods, and plain goods (if to be treated at all) are sand blasted to help retain the finish. Of course it's practice that does the trick. Quite a number of finishes may be produced by working at these same finishes with the liquid oxidize and dust; and the different finishes can be produced on gold by the different materials named in different ways and various colors plated to start on. Of course if they were tried under skilled personal supervision results could be guaranteed. But with a thorough attention to details, they will produce the results stated above.

There are several kinds of blasts, as follows: The regular sand blast with coarse sand or quartz; the use of 90 emery, 150 emery and the steel blast with pulverized steel chips, each giving a different effect when finished. Also the pressure of the blast has much to do with the change, as the harder the air pressure (at times sixty pounds) the sharper and deeper the cut. This blasting is always done before the job is plated and the job must always be polished and buffed and washed before blasting. And if it is necessary to have the high lights bright they may be burnished or buffed before as well as after plating.

The blasted goods must always be dipped in a good acid dip and wet wheeled before plating. The coarse sand blast is always dry steel wheeled before dipping in acid; the emery blast goods never, as with the wet wheeling before and after plating, and also dry wheel before, there would be too much smoothness to the finished job.

The brushes used to brush down the job are of different grades of hand brushes, according to the class of work, as a job with deep hollows will need a harder brush than is necessary on a job which is comparatively smooth. These brushes are of the ordinary shapes. The brushes used to apply the oxidizing liquids are round brushes, medium hard. The smaller one to put on liquid with is three-fourths inch in diameter. The large one, to stipple, or dry off and even up with, is the same style brush one inch in diameter. By stippling, I mean to strike endwise. The brush to apply the dusting powders with is the one-inch Fitch lacquer brush, chisel shaped. Use a separate brush for each class of powder; don't use one for all. This is true also with the round oxidizing brushes. Keep the brushes used for picric acid separate from those used for picric and catechu, etc. When they get too dirty, they may be washed out by dipping in hot water and shaking out; repeat until clean and press into shape and let dry out. To use the brushes to apply the oxidizing, dip in the liquid and brush off the surplus on the edge of the dish as much as possible and then with a downward swing shake out the excess; apply it to the job and then take the other brush and stipple until the finish is even.

The dusting powders are put on by dipping the end of the brush in a little of the powder and then put it on to the job with an end-striking motion, lightly. Do not brush it on as if painting. The umber used is burnt umber and the rottenstone and lampblack must be of the best quality. If cheap lampblack is used, it is apt to be greasy and looks streaked on the job. Rottenstone must be of the best grade, well bolted, and then thoroughly calcined.

The oxidizing liquids are as follows:

No. 1.	Alcohol	4 ounces.
	Picric acid.	2 ounces.

This makes a dark greenish shade and is a dark color if brushed.

No. 2.	Alcohol	4 ounces.
	Picric acid	1 ounce.

This is not so green as No. 1, more of a yellowish green.

No. 3.	Alcohol	4 ounces.
	Picric acid	½ ounce.
	Powdered catechu added.	

This is of rather a brownish, smoky color, not very green.

No. 4. Is No. 2 with a little powdered gamboge added.

The tint is a greenish yellow, smoky.

No. 5. Is alcohol with a little gamboge added.

No. 6. Is alcohol with double the amount of picric acid as for No. 1, and also with a little gamboge added.

It is better when using this to have the job just warm (not hot) and smear it on; when cool, clean it up and dull the finish. A very good oxidize to smear on, and it brushes down very green. Do not stir up the liquid after starting to use it, but it should be well stirred at the beginning. Of course these colors called green are not a real green, like green paint, but they are of a greenish tinge, smoky, like the French finishes on bronzes. After applying the picric acid dip if the work does not oxidize readily it should be exposed to the fumes of ammonia, which will hasten the oxidizing and produce the green sediment.

The dusting powders used with these liquids are as follows:

No. 1. Umber and rottenstone, thoroughly mixed to form a light brownish mixture.

No. 2. Umber, catechu and rottenstone, to make quite a reddish mixture.

No. 3. Lampblack and umber, a very dark mixture.

No. 4. Lampblack and rottenstone, to make a greyish mixture.

No. 5. Is No. 1 with about one-third as much more rottenstone added; it is a dark brownish mixture.

No. 6. Lampblack and umber, not so dark as No. 3, but with more umber added to it.

When making up these mixtures of powders and liquids, and before using up all of the powders, take some of each powder on a sheet of paper and prepare some more of it, so that you can match the color. By so doing and making a sample for each finish, both colors, that is, one when plated, before oxidizing, and one after it is oxidized, any jobs can be made up as per sample at any time.

When oxidizing, if you are desirous of making the job more greenish, or you wish it to brush more evenly, breathe on the job until it seems to make the liquid moist; then either brush or strike blows with the brush. Strike especially to reach work with deep hollows. If the work is brushed or pounded too much, it will make the job glossy and dirty. It is better to oxidize with the liquid and brush and pound a second time than to try to do all at once, or with one oxidize. The best way is to go over the whole job for one operation and then again for the next operation, rather than to try to finish up each piece completely at once. By doing the whole job as recommended, the work is more uniform.

These finishes are nearly all plated first in a green gold solution and are to match French colors. This class of work is rarely lacquered.

TO APPLY THESE FINISHES.

No. 1. Bronze metal; 150 emery blast; ornamental parts burnished before and after plating. Plate in green gold, a nice light yellow, not too dark. Brush over with liquid oxidize No. 2 twice and stipple each time. Brush down a little until the work is of a nice greenish shade and dust over lightly with No. 1 dust.

No. 2. Bronze metal; 150 emery blast; no burnishing. Plate in green solution to a light color, almost like brass. Oxidize twice with liquid oxidize No. 2 and stipple each time; then oxidize and stipple with liquid oxidize No. 3, then brush lightly to darken and dust lightly with No. 6. Fill in matte and ornamentation with catechu and lampblack in alcohol; paint in with a pencil brush; let dry a minute. Brush out the excess and pound lightly to even up the matted surfaces.

No. 3. Brass metal; 150 emery blast; burnish ornamental and high parts. Plate a light color in green solution. Oxidize with liquid oxidize No. 2. Stipple and repeat and then paint once with No. 3; rub over the plain and high parts with alcohol, with a little catechu added and wipe off lightly. The plain burnished parts are then rubbed over with thinner with a drop of lacquer added, so that it just dulls the job.

No. 4. Bronze metal; 150 emery blast; no burnish. Plate in a green solution to a light greenish yellow. Oxidize once with liquid No. 2; stipple and oxidize with liquid No. 3 and again stipple. Dust lightly with No. 4 dust. Fill in the ornamentation with catechu and rottenstone in alcohol. When dry brush out the excess until it just shows a dusty, brownish grey in the hollows.

No. 5. Bronze metal; fine sand blast. The fine sand blast is made with a low air pressure, so that it does not cut deeply or roughly. Buff on the high parts before plating and burnish them after plating. Plate in a green solution to a light yellow green. Oxidize with No. 2 reduced until very weak with water; brush and stipple and if not dark enough repeat the operation. When dry lacquer with a plain white lacquer. Flow the lacquer over and do not brush much, or it will make the job look streaked. When the job is wet with No. 2 oxidize, it shows what the color will be when the job is lacquered. Color a greenish yellow. This finish is very handsome and durable.

No. 6. Cast brass metal; plate in green gold to a light color and then burnish; as brass metal burnishes wavy with a little pressure, all goods for this finish must be cast brass metal. Wrought metal will not burnish wavy, like cast. Brush over with a little catechu and umber in alcohol. Repeat until the work has a dull, greenish, antique finish. The filling should be dark and brownish in tint. Rub with a cloth and gamboge in alcohol to make it more yellow and with a cloth dipped in No. 2 to make it more green. Burnish the high parts also.

No. 7. Louis XVI finish. Brass metal; no blast; dip in acid, chase the border and any figures. Plate to a nice light green in a green solution. Burnish the high and plain parts before and after plating. It will burnish wavy. Oxidize with a brownish mixture of umber, catechu and a very little lampblack in alcohol. Brush and wipe off and, if too green, wipe over with a cloth dipped in alcohol, with a little gamboge added. If too yellow, wipe with a cloth dipped in picric acid dissolved in alcohol. Dust, if necessary, with a little plain rottenstone to dull the surface. Color matte parts a brownish red, dark color, and do not have too much filling in the matte, neither should it be too dark.

No. 8. Bronze metal; sand blast heavily. Burnish the high parts before and after plating. Plate in a green solution to a dark, yellow green. Brush with liquid oxidize No. 2; stipple and repeat; then brush once with liquid oxidize No. 3. Dust lightly with No. 1 dust. On large crooked pieces it is not necessary to dust, but you can let the job go of a nice, dark, greenish color, with just a tinge of brown.

No. 9. Brass metal; for ornamental goods with 150 emery blast for plain goods, burnish wavy before and after plating. Plate in a green solution to a green brass color. For ornamental goods, oxidize once with liquid oxidize No. 3 and dust with dust No. 5, wipe off the high parts to brighten them and wipe over with liquid oxidize lightly, to get a green tinge. If not green enough, use liquid oxidize No. 1. For plain goods wipe over with liquid oxidize No. 3 lightly and then wipe over lightly with gold dye No. 44 (Egyptian Mfg. Co. make), to dull.

No. 10. Brass or bronze metal; no blast; run in acid copper solution to make the matte parts dull. Brush quite dull with rottenstone before plating. Plate in a green solution to a yellowish green; lacquer with lastina lacquer, with gold color No. 14 added. This color is a nice yellow color, with just a reddish tinge. For ornamental goods, the same solid dull color.

CHAPTER XVII.

THE LACQUERING OF PLATED WORK.

Lacquering is the coating of any metal with a hard, skinlike transparent film, either colorless or colored as desired, the purpose being to improve the appearance of the finished article and to protect it from the tarnishing and corroding influences of the atmosphere. It is also of value in protecting the plate from being worn off as readily as it would be if not lacquered. The lacquered articles may be wiped off with a soft, damp cloth, or dusted; they may even be washed with lukewarm water and soap, if necessary. Lacquer improves the appearance and increases the durability of all brass, bronze and copper goods, also sterling silver and silver and gold-plated goods.

The susceptibility of most metallic surfaces to atmospheric influences is so great that it is indispensable to lacquer them to protect them. Even packing in damp paper or contact with the hand may produce sufficient oxidation to entirely spoil the appearance which the metal is intended to produce.

The protecting layer must be such that it must cover without concealing the metal or affecting its luster, and must, of course, have no tendency to oxidize it or injure its brilliancy in any way. Ordinary spirit lacquers are quite unsuitable, as they change the appearance of the surface entirely. The lacquers which answer the purpose fully—i. e., remain invisible while affording full protection—are the celluloid lacquers. They are also so elastic that they never peel or crack off. They may be easily made by the plater in an emergency, but should always be bought where possible, as the purchased article will be found to be both cheaper and better.

If the plater desires to make such a lacquer, he may do so by dissolving transparent celluloid in a mixture of alcohol and ether. As soon as the solution has become clear by standing it is ready for use. If unable to purchase celluloid he may make that by taking collodion wool, the form of gun cotton used for preparing collodion by photographers, and dry it over sulphuric acid in an air-tight case for thirty-six to forty-eight hours. Then put it into a flask with, for every pound of it, three pounds to four pounds of ether, and three pounds to six pounds of very strong spirit. In a few days solution will be nearly or very nearly complete. Pour off the clear liquor from the sediment, if there is any, and add one-quarter to one-half pound of camphor for each pound of collodion wool used. The lacquer is finished as soon as the camphor is dissolved. It can be diluted with spirit if required, and will give an invisible but hard and elastic coating. These celluloid lacquers are far more durable than simple collodion lacquers. They will not crack, even in coats several millimetres thick. They can be dyed if wished. with a solution of aniline dye in spirit.

The celluloid lacquers should not be applied with a brush, and the coats must be dried at a particular temperature or they will become iridescent. The object to be lacquered being perfectly clean and free from grease, it is dipped by being suspended by a fine wire, immediately removed, drained, and dried at a temperature not exceeding 95 deg. F. till free from smell. To economize lacquer, the dipping should be done when several objects have accumulated, and should be carried out with all convenient speed, and the superfluous lacquer should then be at once rebottled. When an object cannot be dipped the lacquer may be applied with a fine hair brush, but dipping should always be the method resorted to whenever practicable.

Nickel is the one metal used by platers that is not protected or benefited by the use of lacquer; being very hard and of a nontarnishable nature, the use of lacquer is of little or no value upon nickel-plated objects.

There are several grades of lacquer for dipping and brushing, which are suited to the different classes of work. There are colors which may be obtained for mixing with lacquers for getting the different shades of gold. This colored lacquer is used upon gold-plated goods, brass and brass-plated goods, such as lamps, chandeliers, brass beds, hardware and furniture trimmings and other articles of brass and brass plate. The coloring is added to the lacquer a very little at a time. In the case of brush lacquering, where a small quantity is used, two or three drops will be found sufficient to get the desired shade. It should be well mixed up and allowed to stand an hour or more, so as to get an even color, before using.

In lacquering it is very essential that the object should be perfectly clean, and free from dampness, grease or finger marks, as any imperfections or dirt will show up badly under the lacquer. In lacquering highly polished articles of brass or plate, they may be polished and buffed up bright, then washed out to remove all grease and buffing compound, then run over a clean buff lightly, not using any rouge or buffing compound. This will leave the goods in a clean and highly polished condition. Any grease spots or dampness will cause the lacquer to turn white while drying. In that case it is usually best to remove the lacquer and refinish the article; still, if the work has only a white spot here and there, it may be removed by applying a little lacquer thinner to the spot with the tip of the finger. This white or clouded appearance is more apt to occur in using the dip lacquers.

In applying brush lacquers a fine camel hair brush should be used, one that is well made and will not drop its hairs while being used, as a few stray hairs spoil the appearance of the work, and once on the work cannot well be removed without marring the finish. Goods to be lacquered should not be cold, yet not hot; the best results are obtained by having the articles just perceptibly warm. If the work is too warm the lacquer will start to dry before the brushing operation is finished, thus making the work rough and streaked. New lacquer is usually ready for use just as received, but as it becomes exposed to the air from time to time it becomes thick and the addition of lacquer thinner is necessary to get the proper consistency. In reducing lacquer care should be taken to use thinner of the same grade as the lacquer.

Brush lacquer should be used as thin as is possible without showing the rainbow colors. Such colors are usually due to too much thinner. In case the work shows the rainbow colors it may be given another coat over the first one, but not until the first is thoroughly dry. In using brush lacquer the object should be brushed all one way as much as possible. Avoid going over the same place twice and use enough lacquer so that it can be spread and flow easily, but not enough to form a drip while drying. One of the essential points in good lacquering is to handle the work as quickly as possible, getting the article covered and hung up with very little handling.

Dip lacquer should be used in a vessel of suitable size and shape for the work to be dipped. Tin vessels can be made of the required shape and size, having tight covers, which should be kept in place when the lacquer is not being used. Galvanized iron or zinc vessels should never be used to contain lacquer, especially the cheaper grades, as the action of the lacquer upon the zinc soon causes it (the lacquer) to become thick and stringy and of a greenish color.

An arrangement of suitable hooks or rods should be placed immediately above the lacquer tank, so that the lacquered work may be hung up over the tank to drip before going into the drying oven.

In lacquering large pieces of silverware or other articles of peculiar shape the piece should be studied before dipping, to see which way it may be hung to dry so as to give the lacquer the best chance to flow off and leave as little drip as possible. When dip-lacquered articles show the rainbow colors, the article may be redipped after this first coat is dry, which will usually remedy the difficulty.

It is useless to try to do good work with lacquer in the same room with other work, or where there is machinery, as any dust settles on the lacquered articles while drying, thus spoiling the finish. I have seen the lacquering department established in one corner of the buffing and plating room, having all these in one room and a small room at that! Then people wonder why they can't get good work! Good work is simply impossible under such conditions.

The lacquer room should be separated from the other departments by a partition, should have as good light as possible and where large quantities of lacquer are used the room should be made fire proof, or as nearly so as may be. This may be done either by plastering or the use of sheet iron, asbestos or other suitable fire-proof material, which will prevent fire from spreading in case of accident, which is, however, not likely to happen if due caution is observed in handling the lacquers.

Steam is the best possible agent to use for heating the lacquering ovens, where it is available all the year around, as it should be in any large shop. Steam for drying and incandescent lights, when artificial light is necessary, would reduce the danger of fire to a minimum. Where gas is used for heating ovens and lighting purposes in the lacquer room, more care is necessary, as lacquered work allowed to drip in a hot oven is liable to cause trouble. About 100 deg. F. is the proper temperature for drying work. It should be allowed to dry slowly and all the surplus lacquer should have dripped off before the work goes into the oven. After the lacquer has been thoroughly dried, more heat may be applied and the lacquer well baked on the article which makes it very hard, close grained and tough, giving better wearing qualities. Especially is this so with dip lacquer. To do good work with lacquer takes time and practice. Girls become very proficient at this work with the brush, with a little experience.

The lacquer room should be as well ventilated as possible, as besides being readily inflammable, the gases from the lacquer have a detrimental effect upon the throat and lungs of the operator.

Lacquer brushes when not in use should be kept in a cup or basin containing thinner; this keeps them soft and pliable.

Long rods or pieces of tubing are sometimes troublesome to lacquer with the brush, as in lacquering long pieces some spots are very liable to be left unlacquered. These spots or streaks will soon become tarnished, spoiling the appearance of the whole job. To overcome this and avoid the possibility of skipping any part, the rods or tubes should be hung or stood up at full length; after being wiped clean, take a clean cotton rag, saturate it thoroughly with the lacquer, wrap it twice loosely about the rod or tube and run it gently from one end to the other. If carefully and properly done, it is possible to do nice work in this way much quicker than by brushing.

In lacquering small work plenty of hangers and hooks should be provided. If the work is something not suited to hooks or wires for hanging in the oven, trays made of wire netting with a mesh small enough to prevent the work from falling through are used.

For removing old lacquer from goods to be refinished, it is the usual method to immerse them in hot lye until the lacquer peels off. Brush lacquers are much more easily removed from the work than dip lacquers; also cheap lacquer is more readily removed than the better grades. Some classes of work that have been lacquered would be injured by the hot potash. Work which has been soft soldered will have the lead attacked by the strong lye, coating the whole object with a film of lead or tin. In that case it must be entirely refinished. The different kinds of oxidized work are affected by hot lye and to save the finish the work should be closely watched and removed as soon as the lacquer begins to loosen from the work; then the remaining lacquer may be removed by the use of boiling hot water.

To remove the lacquer from work which for any reason cannot be immersed in potash, very hot water may be used. It takes somewhat longer than the potash, but the finish on the goods will not be disturbed.

For removing lacquer in patches from a piece of work, or from small pieces, or from such things as the backs of brushes, mirrors and combs, where neither potash or hot water can be used, lacquer thinner or alcohol may be applied until the lacquer is removed. Lacquered articles sometimes become marred or chipped in spots. It is useless in such cases to try to relacquer or patch the spot as a satisfactory job can seldom be done in this way; the only way is to remove the lacquer and relacquer the article.

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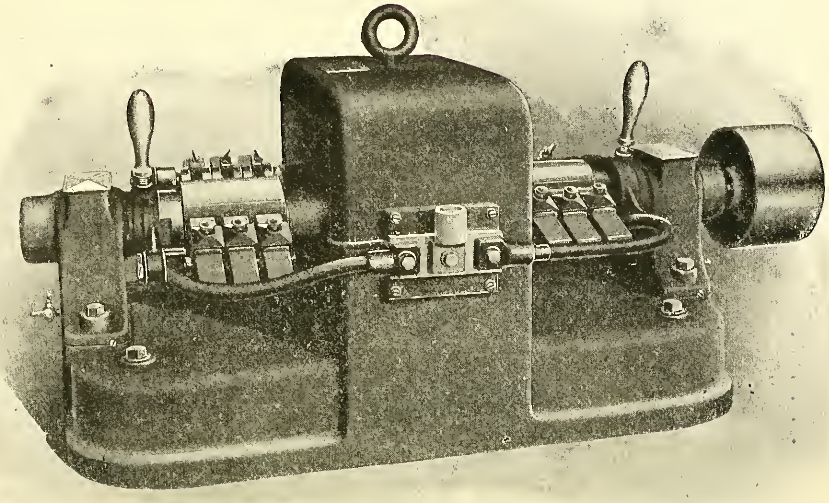

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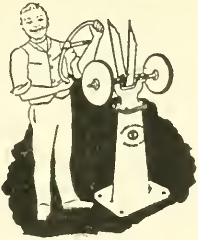

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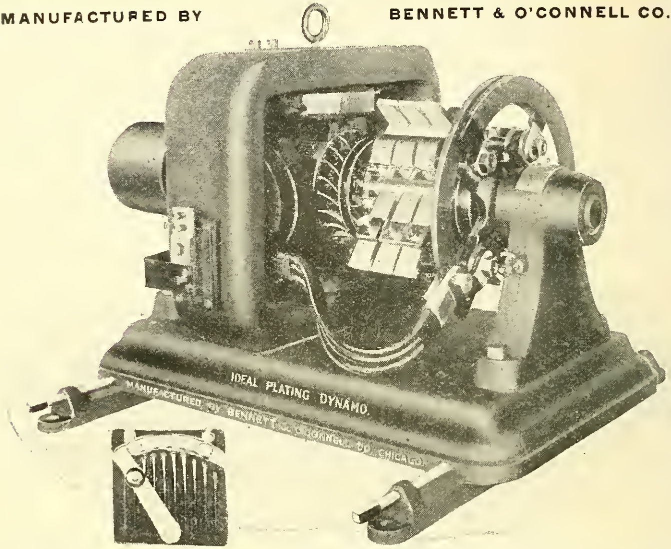
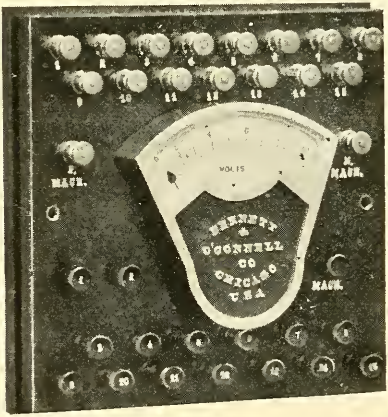


Built in eleven sizes, from 50 amperes to 2,500 amperes. Our multipolar compound wound dynamos will automatically hold their voltage constant from no load to full load. Write for descriptive catalogue and prices.



This illustration shows our improved volt meter for continuous current of low potential (1 to 10 volts) built in four sizes,

No. 1 is provided with two terminals or binding posts for connection with dynamo or one tank.

No. 2 is provided with six terminals or binding posts for connection with wires leading to five tanks and dynamo.

No. 3 is provided with terminals for connection with ten tanks and dynamo.

No. 4 is provided with terminals for connection with fifteen tanks and dynamo. To ascertain the voltage at any one tank, press the button that has corresponding number on terminal and the needle at once indicates the voltage in the tank.

Continuous reading of any one tank or dynamo can be made by slightly pressing and turning the button until locked. These instruments are highly finished with cast aluminum case and mounted on polished mahogany base. Write for Prices.

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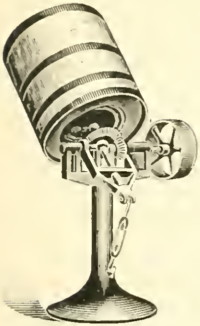

We call attention to our plating and tumbling barrel, for plating and tumbling small articles of work which can not be easily or profitably handled in the usual way.

It will not only plate and tumble the work better and quicker, but it will surprise you to note the amount of work one of these barrels will turn out. It saves time, labor and material.

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If interested would be pleased to hear from you, and your orders or inquiries will have my prompt and careful attention.

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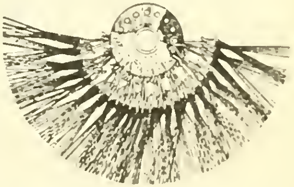

will produce the satin finish or sandblast effect so much in use at the present time, on white metal, brass, German silver, steel, cast iron or aluminum. They are simple in construction and can be readily operated by any one without previous experience in satin finishing. We would call your attention to the construction of the patent wire tufts as shown in cut, as by reason of this the Yale Satin Finish Brushes are more durable, will do the work better, quicker and more economically than any other brush on the market.

The brush is becoming a favorite among all silver plate, brass and chandelier manufacturers, job shops and jewelers. To any one who may be fortunate enough to see one of our folders and think the brush can be used in their business, we will be pleased to promptly answer all correspondence in regard to same.

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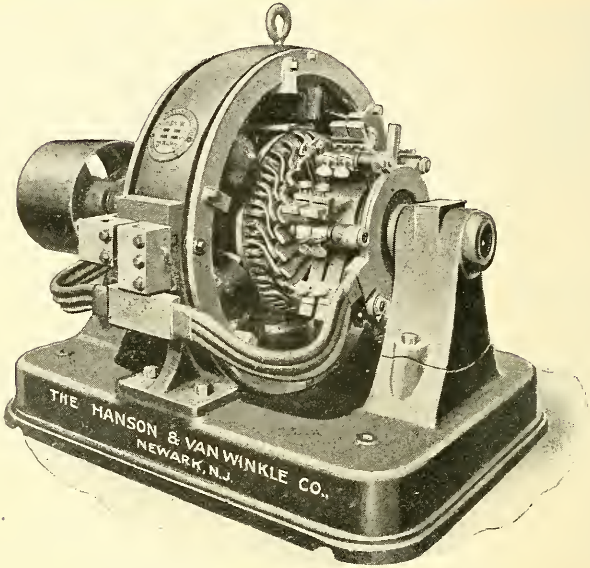

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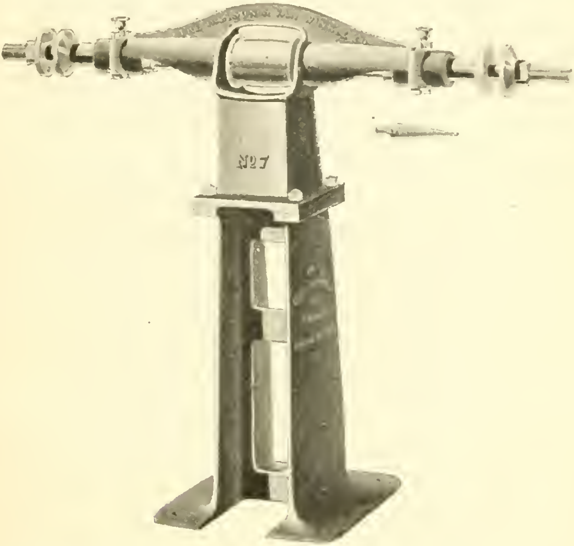

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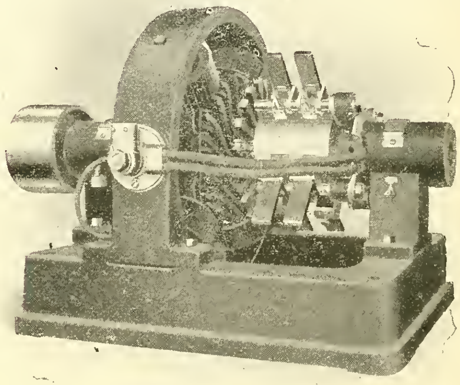

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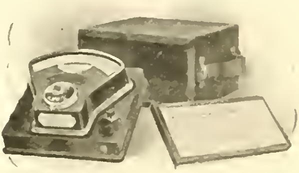

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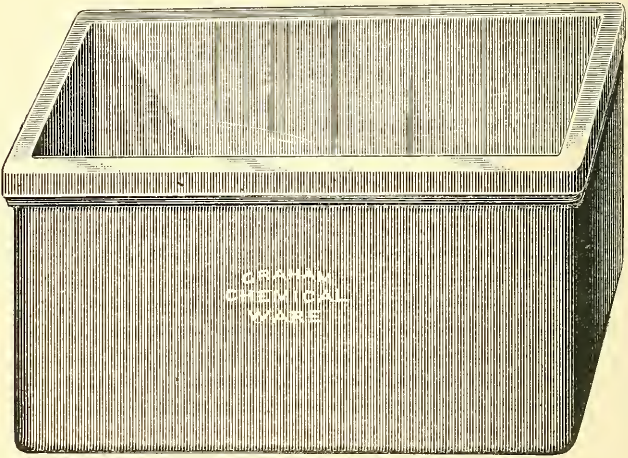

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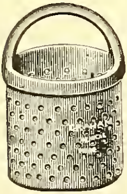

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